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[NOTICE.]

Thirteenth Annual Meeting, Pacific Coast Gas Association.

PACIFIC COAST GAS ASSOCIATION,
OFFICE OF THE SECRETARY,
SAN FRANCISCO, June 16, 1905.

The Thirteenth Annual Meeting of the Pacific Coast Gas Association will be held in the Assembly Hall of Mechanics' Institute, No. 31 Post street, San Francisco, Cal., July 18th, 19th and 20th. On the 17th the annual meeting of the Directors will be held at 8 P.M., Room 617 Rialto Building. All members are invited to attend the session of th, Board. On Tuesday and Wednesday regular sessions will be held from 10 A.M. to 12:30 P.M., and from 1:30 to 5:30 P.M. of each day.

At 6:45 P.M. of Wednesday the usual banquet will be held in Delmonico's restaurant.

On Thursday the annual excursion with luncheon to members, their families and friends, is arranged for. Headquarters for members will be on the sixth floor of the Rialto Building.

The following papers will be presented:

"Commercialism at Gas Association Conventions," by Mr. Lucius S. Bigelow.

"A Gas Man's Catechism," by Mr. John A. Britton.

"The Public Utility Corporation and the Municipality—Their Legal, Equitable and Economic Relations," by Mr. H. C. Brown.

"Wrinkles," Mr. Geo. S. Colquhoun, Editor.

A paper by Mr. H. L. Doherty; title to be announced.

"Question Box," Mr. E. C. Jones, Editor.

"Something About the Physics and Chemistry of Gas," by Mr. F. C. Jones.

"Gas Arcs," by Mr. W. M. Kapus.

"Association History," by Mr. Geo. P. Low.

"Utilization of Gas Engines in Connection with Long Distance Electric Transmission," by Mr. John Martin.

"Notes Regarding Gas Tars," by Mr. P. W. Prutzman.

"The Compression and Transmission of Illuminating Gas," by Mr. E. A. Rix.

"Experiences," Mr. R. P. Valentine, Editor.

"Suggestions for Increasing Gas Consumption," by Mr. J. W. Wrenn.

A paper by Mr. G. C. Holberton; title to be announced.

There will be an unusually interesting display of novelties in gas appliances during the session, special attention being given to exhibition of articles of merit and originality. Applications for membership will be received until Tuesday, July 18th, 1905.

In increase in membership, in number of interesting papers, the 13th, annual meeting promises to surpass all others, but to insure this, attendance of members is especially required. Make it a banner year in attendance; mix with your fellows; do team work.

Discussion of project for National Association will also be taken up.

In order that adequate arrangements be made for the meeting, it is essential to know in advance the number of members who will attend each of the functions. To that end kindly fill out and mail at once the inclosed postal, indicating by "Yes" or "No" answers to the various questions. Yours in the faith, JOHN A. BRITTON, Secretary.

[OFFICIAL NOTICE.]

Wrinkle Department, Western Gas Association.

OFFICE OF EDITOR, WRINKLE DEPARTMENT,
WESTERN GAS ASSOCIATION,
182 WISCONSIN STREET, MILWAUKEE, WIS.,
June 27th, 1905.

To the Members of the Western Gas Association: Your early attention and assistance are earnestly solicited in connection with the above Department for 1906. We are now ready to receive contributions and any device, plan, scheme, wrinkle, suggestion, formula or new method will be warmly welcomed. A full description, with sketch or photo, should accompany each contribution. Give us your help to make the 1906 Wrinkle Department a success. Thanking you in advance for your kind assistance, I remain, Yours truly, B. MCADAM, Editor.

[OFFICIAL NOTICE.]

Respecting the Official Work of the American Gas Light Association.

AMERICAN GAS LIGHT ASSOCIATION,
SECRETARY'S OFFICE,
530 Broadway, N. Y., Dec. 13, 1904.

To the Members American Gas Light Association: As there seems to be some misunderstanding respecting the standing of the official management of the Association, members will please note that the un-

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dersigned is the Secretary of the Association, and that Mr. A. E. Forstall is carrying forward the work of the Practical Class. All correspondence in connection with the Practical Class should therefore be addressed to Mr. A. E. Forstall, 58 William street, and all other matter pertaining to the Association to MR. GEORGE G. RAMSDELL, Secretary, at the above address.

[NOTICE.]

Wrinkle Department, Ohio Gas Light Association.

OHIO GAS LIGHT ASSOCIATION,
OFFICE OF THE WRINKLE DEPT.,
719 CITIZENS BUILDING,
CLEVELAND, O., June 13, 1905.

The Wrinkle Department of the Ohio Gas Light Association is now ready to receive contributions for the 1906 collection, and a sketch or description of all devices, formulæ and methods of accomplishing objects pertaining to the gas business, is respectfully solicited.

Please send a written explanation, accompanied by any sketch, photograph or drawing, to the above address, or a description alone will suffice.

Hoping to receive prompt compliance, Yours very truly,
W. E. STEINWEDELL, Editor.

BRIEFLY TOLD.

DEATH OF MR. LIDDON FLICK.—A correspondent in Wilkes-Barre, Pa., writing under date of the 5th inst., incloses the following respecting the sudden death of Mr. Liddon Flick of that city: "Mr. Liddon Flick, a prominent capitalist of Wilkes-Barre, died suddenly the morning of the 2d inst., succumbing to a cerebral hemorrhage. He was interested in a large number of companies in this city and elsewhere. He was born in 1858, was graduated from Princeton in the Class of 1882, and from the Columbia Law School in 1884. He was admitted to practice at the New York Bar in 1885, and at Pennsylvania the following year. Inheriting a fortune from his father, he devoted his energies to financial development and was President of the Wyandotte Gas Company, of Bethlehem, Pa.; the Vineland (N. J.) Light and Power Company; the Peoples Light Company, of Pittston, Pa., and he also organized and was a Director in and Vice-President of the Wyoming Valley (Pa.) Gas Company. He was President and Editor of the Wilkes Barre *Times*, was a large owner in the Consumers Gas Company, of Wilkes-Barre, was connected with the Grand Opera House Company, the Wilkes Barre Lace Company, and several prominent business enterprises. He was also identified with the Muskegon (Mich.) Light and Traction Company. He is survived by his wife and an infant daughter."

NOTES—

MR. JAMES MURRAY has resigned the position of Superintendent of the Grand Island (Neb.) Gas Company.

MR. CHARLES C. VAN BENSCHOTEN, who built the New Rochelle (N. Y.) gas works in 1867, and who operated the same until the property was sold to the American Gas Company, of Philadelphia, died at his home in White Plains, N. Y., Sunday, June 26th. He was in his 77th year.

ADVICES from Memphis, Tenn., dated the 5th inst., are to the effect that Mr. J. T. Harahan, Third Vice-President and General Manager of the Illinois Central Railroad, has been chosen Vice-President of the Memphis Consolidated Gas and Electric Company, succeeding Mr. Frank G. Jones. Capt. R. A. Speed, of Memphis, was recently elected President, to succeed Gen. S. T. Carnes, resigned, so the reorganization of the Company is complete. The controlling interest in the Company is owned by Eastern capitalists, but the local shareholders are greatly pleased over the appointment of Mr. Harahan, who has done very much to advance the material interests of Memphis.

AT the annual meeting of the Louisville (Ky.) Gas Company the Directors elected were, Messrs. Udolpho Sneed, John Stites, Hector V. Loving, D. X. Murphy and F. M. Sackett.

ON July 24th application will be made by Messrs. Charles F. Cattell, William Corcoran and Patrick H. Corcoran, all residents of West Chester, Pa., to the Governor of Pennsylvania for a charter for the Malvern Gas, Fuel and Power Company, and the Malvern Gas Company, which concerns propose to manufacture and sell gas for light, fuel and power purposes to the residents of Malvern, East Whiteland, Willistown, East Goshen, Eastown and Tredyffrin. Mr. Cattell is Superintendent of the Gas Company of West Chester.

[OFFICIAL REPORT.—REVISED BY THE SECRETARY.—CONTINUED FROM PAGE 8.]

TWENTY-EIGHTH ANNUAL MEETING, WESTERN GAS ASSOCIATION.

HELD AT CHICAGO, ILLS., IN THE AUDITORIUM HOTEL, MAY 17, 18 AND 19.

FIRST DAY—AFTERNOON SESSION.

The President introduced Mr. Irvin Butterworth, of Grand Rapids, Mich., who read the following paper on

THE PREVENTION OF STOPPAGES IN SERVICES, METERS AND HOUSE PIPES DURING COLD WEATHER:

The majority of the cities in which the gas companies represented in this Association do business are located in the northern half of the United States, where the winters are so long and severe that much trouble is experienced from the stoppage of service pipes, meters and house pipes by deposits of frost and water condensed out of the gas. This is particularly true of the most northern cities; and with the exception of those in the extreme south, none of the companies are entirely exempt from this trouble. In this paper I wish in the first place to point out the seriousness of this imperfection in the gas business of to-day, and in the second place to mention and comment upon some of the remedial measures that have been proposed for its relief, or that have already been applied thereto with more or less success in European countries.

It is my firm conviction that the time has gone by when a gas manager can afford to content himself with following the methods now in vogue in this country for treating the routine difficulties incident to the distribution of gas in extremely cold weather. It no longer should suffice, nor indeed does it suffice, for a gas company to resignedly and complacently assure its consumer who suddenly finds his supply of gas cut off, say in the early hours of a long winter evening, by an insidious and unsuspected deposit of frost in his service pipe, that such an interruption is now and then unavoidable in the gas business, that there is no way of preventing an occasional stoppage of this kind, and that a man will soon be out to free his service pipe of the obstruction and restore the flow of gas. I feel so strongly on this subject that I regard it as nothing short of an actual calamity for a gas company to have even one of its consumers thus suddenly deprived of his supply of gas on a single occasion. This may seem like an extreme view, but it must be remembered that people nowadays expect, and are warranted in expecting, a much greater degree of perfection, refinement and reliability than formerly in the mechanical devices and means through which the common necessities, comforts and conveniences of their everyday life are supplied. A few years ago the citizen rode to and from his place of business in winter in a slow and comfortless horse car. Now he is whirled along with smoothness and swiftness in a comfortable car, heated by electricity or otherwise. The manufacture and distribution of gas have been carried on as a business for a hundred years, and the thinking layman, in this age of mechanical progress and refinement in other long established industries, expects, and has a right to expect, that by this time surely, gas men have devised means and methods for insuring the continuity of the gas supply at his premises in winter as well as in summer. And yet during 3 months of the winter of 1903-4 in the little city of Grand Rapids, where the distribution of gas is accomplished along rather better lines than the prevailing good practice of the day, most of the service pipes being boxed in tar concrete, there were 3,000 individual interruptions of the gas supply due to frost and water in the pipes and meters. Detroit had relatively as many, and if the companies in other cities should make an honest confession, the disclosures by each of them would be equally discreditable to the gas business in these modern times. I am aware that the winter mentioned was exceptional in the severity and persistency of its cold weather; but the inconvenience, discomfort and distress, not to say the actual damage, that gas companies cause their consumers, even in average winters, by their failure to provide some pure preventive of these interruptions, are a sad commentary on either their engineering skill or their business judgment. Furthermore, gas is now used in the average household for so many different and important purposes that an unexpected stoppage of the supply by day or by night, but particularly by night, has become a much more serious matter to the consumer, and therefore to the gas company, than formerly. Time was when the gas was used for light only, and, in many cases, in only two or three rooms in the house. Lamps or other means were always conveniently at hand for obtaining light from oil, or otherwise, on short notice, in the

event of the failure of the gas. The sudden stoppage of the supply of gas under those circumstances was not a very serious matter and consumers of those days were patient and forbearing; but nowadays, especially if the company's new business department has been doing its full duty, the average consumer depends altogether upon gas, not only for lighting his house throughout, but also for cooking, for heating water, for warming some of his rooms and for other purposes, with no other means at hand as a quick substitute for the gas for either purpose. The interruption of the gas supply in such cases cannot be otherwise than a most serious matter to the consumer; and in the not infrequent event that the house at the time contains visitors, or that a party or other social function is in progress, extreme annoyance and humiliation add to the consumer's irritation and chagrin; while in case of sickness, the consequences may be even calamitous.

It is considerations such as these that impel me to the conviction expressed above—that gas companies, in northern cities at least, should not content themselves with following the present antiquated and inadequate methods of dealing with these troubles. It is not right, nor is it good business, for the company to wait until the unfortunate consumer telephones that he is out of gas and then send a man, perhaps half an hour later, with a can of wood alcohol, a pipe wrench and a lantern, to cut the frost out of the service pipe. This is "locking the stable door after the horse is stolen" with a vengeance, especially from the consumer's standpoint. I admit that most companies have sought to reduce the number of these interruptions of the gas supply by laying all new services at a greater depth and by keeping a list of all services that freeze up during the winter and then so enlarging or protecting them during the following summer that their stoppage from this cause is not liable to recur; but this is only an imperfect and partial remedy. The following winter may be much more severe, resulting in a recurrence of the trouble in those same services and in its fresh appearance in many others; and even with no apparent difference in temperature conditions, services and house pipes that do not freeze or stop up during one winter may, on account of the vagaries of frost and weather, and even from unknown causes, do so during the next. It is practically impossible to entirely anticipate and prevent in this way all freeze-offs and stoppages, although good work may be and has been done in this direction, bringing about as great a degree of immunity from these troubles as is possible under the present imperfect methods of treating and preventing them; but they still leave much to be desired. For, on account of what I regard as the increasing seriousness of our allowing even a single consumer to be without gas on a single occasion, I believe it is our duty, and greatly to our interest, to adopt some new and radical method calculated to completely prevent these difficulties.

Let us now see what choice of such measure we may have, and discuss briefly their relative merits. I will consider the following seven methods, some of which have been tried, while others as yet, have been only proposed. Still other methods have been proposed, but a consideration of the following will suffice for my present purpose:

1. Drying the gas by washing with sulphuric acid.
2. Drying the gas by exposure to calcium chloride.
3. Drying the gas by exposure to quicklime.
4. Drying the gas by exposure to calcium carbide.
5. Drying the gas by compression.
6. Drying the gas by air condensation in overground pipes or air condensers.
7. Reduction of freezing point of vapors contained in the gas by the admixture of alcohol vapor.

It will be observed that all of these methods contemplate some treatment or manipulation of all of the gas as it passes from the holder outlet into the street mains, and that the first six contemplate the removal from the gas of the water vapor contained therein, at least such portion of it as will render the remaining moisture insufficient to cause any trouble; for it is said to have been found, according to Dr. Harrop, that .6 per cent. of water vapor can be safely left in the gas, this being half of a total of 1.2 per cent. which is about the quantity that saturated gas contains as it leaves the holder under average pressure conditions and at a temperature of, say, 50° F., or about 12 cubic feet of water vapor for each 1,000 feet of gas. I would feel that it would be safer, however, especially in extremely cold weather, to remove practically all of the water vapor from the gas, if this can be economically accomplished. Obviously, if the water vapor be removed there will be no stoppages from frost or water, and an incidental benefit which must not be lost sight of would be the prolonging of the life of our meter diaphragms which, as is well known, are greatly injured by condensation in the meters, especially when such condensation is not of an oily nature. The chief object to be attained, of course, is the prevention of stoppages caused by cold weather, and such being the case, any method employed for this purpose need not be operated except during the two or three coldest winter months; but there is not much condensation in meters during the other months of the year in any event. Furthermore, it is generally recognized among gas men that the moisture in the gas favors the deposition of naphthaline, and so by drying the gas we "kill two birds with one stone," getting rid of stoppages from both naphthaline and frost. To my mind, therefore, some method of desiccating the gas would be preferable, if a feasible and economical one could be found, to method No. 7 (the introduction of alcohol vapor), which leaves all the moisture in the gas, allowing it to condense in the pipes and meters and only aiming to so lower its freezing point that it will not congeal. I confess, however, that method No. 7 is the only one that is at present in successful use, notwithstanding the fact that the desirability of distributing desiccated gas has long been recognized, the American Gas Light Association having discussed this question as long ago as 1872. Let us consider the foregoing methods in the order given:

Drying by Washing with Sulphuric Acid.—This method contemplates passing the gas through some sort of material, like pumice stone, wetted with sulphuric acid, which would absorb the water vapor out of the gas and which could then be strengthened for re-use by driving the moisture out of the acid by heat. This method is apt to be the first one to occur to us on superficial consideration, but it is now generally recognized to be impracticable because the acid would rob the gas of too much of its illuminants. Furthermore, a trial of this method in Germany in the winter of 1895-6 showed that it did not prevent stoppages of pipes from the congealing of the benzol. (See "Progressive Age" of April 15, 1896, page 187.) It is likely that no method of desiccation would prevent this. Rut benzol enrichment is not generally practiced, particularly in this country.

Drying by Exposure to Calcium Chloride.—This method contemplates passing the gas through, or bringing in contact with, calcium chloride, which by its affinity for water would absorb the moisture out of the gas. It has been tried with success on the premises of consumers, for instance, in Cracow, Austria (see *Journal of Gas Lighting*, March 13, 1900, page 681), but, so far as I know, has not been attempted anywhere as a means for removing the moisture from all the gas as it enters the street mains from the holder. This method would necessitate not only rather expensive apparatus, but the cost and difficulty of revivifying the material for re-use would probably make it uneconomical.

Drying by Exposure to Quicklime.—This method would be similar to the preceding and probably much more economical, but I cannot find that it has ever been tried on a large scale. From data furnished me by Dr. Harrop, I calculate that with gas at 50° F. 1 pound of freshly burned lime per 1,000 cubic feet would suffice if the gas were properly exposed to it, to reduce its moisture content to .6 per cent. A portion of this lime, equivalent to about .4 of a pound per 1,000 cubic feet of gas treated, could be afterwards utilized in the ammonia concentrator, leaving the net quantity of lime chargeable to the desiccation of the gas about .6 of a pound per 1,000 cubic feet, costing say about ¼ cent. Or if enough lime were used to practically completely desiccate the gas, which would be preferable, it would cost twice this much, or say, ½ cent per 1,000 cubic feet. While the first cost of the lime itself would, therefore, not be excessive, this method might nevertheless not prove as economical as some of the others under consideration on account of the first cost of the necessary apparatus and the cost of handling the material.

Drying by Exposure to Calcium Carbide.—This is a method proposed (originally, so far as I know) by Mr. F. Egner in 1894, who pointed out that calcium carbide "would make a most excellent dehydrating agent, the carbide taking up the water vapor and nothing else, and the resulting very rich acetylene being conducted along with the gas and evidently doing it no hurt." He had in mind the possibility of using it for the purpose which we have under consideration, but, so far as I can discover, the experiment has never been tried, notwithstanding the idea is very attractive. The apparatus for its use would be comparatively inexpensive, but at present open prices, the carbide would cost about $70 per ton, or 3½ cents per pound, and 1 pound of the commercial article (say 90 per cent. pure) would absorb only about 10.5 cubic feet of water vapor, which would be the quantity contained in 875 cubic feet of gas at 50° F. In other words, the carbide necessary to reduce the water vapor to .6 per cent. would cost 2 cents per 1,000 cubic feet of gas treated, while enough to entirely desiccate it would cost 4 cents per 1,000 feet. This method would therefore be quite expensive, notwithstanding the resulting acetylene would enrich the gas

to some extent. The enrichment would not be considerable, if coal gas was being made, particularly if the absorption should generate high temperatures which would be injurious to the acetylene itself and also to the gas being treated. It is not likely, however, that this would be the case.

Drying by Compression.—This method contemplates compressing the gas by an ordinary compressor or otherwise, to a point that would "squeeze out," as it were, enough of the water vapor to render the gas safe from freezing, and then releasing the gas into the mains at ordinary low pressure, for distribution. As stated above, it is said that a residue of .6 per cent. of water vapor may be left in the gas with impunity. While this seems doubtful, it is a fact that the removal of even a small portion of the water vapor seems to have an astonishingly large effect in the reduction of the number of freeze-offs. An examination of the complaint books at Detroit during the winter 1903–4 shows that there was a decided falling off of complaints in the vicinity of their high pressure pumping lines, notwithstanding the gas was subjected to only 2 pounds pressure; and yet compressing gas under 15 pounds pressure removes only half of its water vapor, which would, at 50° F., leave about .6 per cent. in the gas. But to do even this would cost about 1½ cents per 1,000 cubic feet, as artificial cooling would also be necessary. In fact, while compressing the gas would be a perfect preventive of freeze-offs and condensed moisture, as is shown by the experience of gas companies that distribute high pressure gas only, yet compressing it for the sole purpose of desiccation, would be much more expensive than some of the other methods. Our consideration of this method brings strikingly to our attention one of the conspicuous advantages of high pressure distribution, namely, the absolute prevention of stoppages from freeze-offs and condensed moisture.

Drying by Air Condensation in Over-Ground Pipes or Air Condensers.—This method of desiccating artificial gas has not, to my knowledge, yet been tried on a large scale, although it is successfully employed by some natural gas companies in removing the entrained water from natural gas. (See American Gas Light Journal of November 21, 1904, page 802.) Although the problem of its application to artificial gas is much complicated by the danger of condensing out the illuminants as well as the water vapor. I confess that this method appeals to me as offering great and promising possibilities. No machinery or chemical agencies are needed, and very inexpensive apparatus can be employed, while the labor cost would be extremely small. All that is required is a system of pipes laid above but not directly upon the ground, or almost any other sort of large air condenser, connected by means of valves with the holder outlet in such a manner that in cold weather the gas could be passed through this condenser, thus subjecting it to air condensation, the amount of exposure being varied by means of valves according to the fluctuations in the temperature of the air, and at no time cooling the gas to a lower temperature than it would reach in any event in passing through the mains and consumers' services. In this way there would be no greater loss of candle power than would occur if the device were not in use. In fact, we could err on the safe side by not chilling the gas below the temperature that it would reach in the warmest service in the city, and still free it of enough of its moisture to secure us, in my opinion, immunity from the frost and condensation troubles that now make the life of a gas man miserable in cold weather. With one intelligent man in charge of this air condenser, it could be manipulated with absolute nicety, producing exact and ideal results if such were necessary. But, in my opinion, the apparatus would do its work sufficiently well for all practical purposes without painfully close watching or micrometer regulation. It would only be necessary not to chill the gas below the temperature that it would reach in the warmest services, and as our troubles from frost and condensation would probably disappear before this point should be reached, the range of temperature fluctuation produced by the apparatus could safely cover quite wide limits. It would probably be necessary to provide duplicate condensers, in order that they might be alternately by-passed to permit the removal, by steam, air or other means, of the frost that would deposit in them from the moisture in the gas.

A conviction of the probable efficacy of this method is forced upon us by well-known experiences of many gas companies. The St. Paul Gas Light Company, during the winter of 1903–4, had much less trouble than usual from freeze-offs, when the opposite experience would naturally have been expected, simply because the weather was so very cold that the quantity of moisture in the gas as it left the holder was in the first place less than usual, and in the second place was nearly all condensed out before the gas reached the consumers' services. In Detroit, during the same winter, there was a system of partially overhead small distribution pipes running to and through various buildings at the gas works. Some parts of these pipes kept continually freezing up until a large iron vessel, made out of a 16-inch gas pipe, which acted as an air condenser, was installed in the main feeder of this system as it emerged from the ground, and immediately the freezing ceased, the moisture, or enough of it, being thus removed. The U. G. I. Companies have for years been in the habit of enlarging their lamp post risers where they leave the ground, the enlarged portion serving as an air condenser and thus practically preventing all freeze offs. In Grand Rapids about one-fourth of the gas consumers live on the west side of the Grand river, the remaining three-fourths being on the east side, where the works are located. The west side consumers are supplied through pipes supported where they cross the river on bridges some 600 feet long. An examination of our complaint books shows that on the east side of the river there were, during the three coldest months of the winter of 1903–4, six times as many stoppages from frost and condensation per 100 meters as there were on the west side, the difference being wholly due to the exposure of the gas supplied to the west side, to the cooling effect of the air as the gas passed through the pipes on the bridges, as other conditions were the same throughout the city. The proposed air condenser at the holder outlet would merely perform this desiccating function for the gas supply of the entire city, only it would do it more thoroughly and with more safety to the candle power, being at all times under full and easy control. It would be used, as I have said, only in extreme weather, being by-passed or artificially cooled during the warm hours of mild winter days and put into use again as the evening coolness and hours of maximum consumption came on. To my mind, this is the most promising desiccating method of preventing troubles from frost and condensation.

The Reduction of Freezing Point of Contained Vapors by Admixture of Alcohol Vapor.—This is the only method that does not involve the desiccation of the gas; and furthermore and unfortunately, it is the only method that is now in successful use. In fact, as far as I know, it is the only method that is now being tried, either successfully or unsuccessfully. It is fully described and illustrated in the American Gas Light Journal, June 15, 1896, page 936. It is the invention of Dr. Bueb, Chemist of the German and Continental Gas Company, of Dessau, Germany, and has, I understand, been patented in this country. It is a scheme and apparatus for introducing into the gas as it enters the street mains from the holders the vapor of wood alcohol, which so lowers the freezing point of the water and other congealable vapors contained in the gas, including benzol, that they do not deposit in the pipes as frost or otherwise. The apparatus is very simple and inexpensive, and consists of an elevated tank containing the alcohol, a regulator for controlling the rate of flow of the alcohol into the vaporizer, a vaporizer for volatilizing the alcohol either by steam or dry heat, and a pipe leading thence in the holder outlet. For temperatures down to 14° F. about ½ of a pint of alcohol is necessary per 1,000 feet of gas, and for temperatures between 14° F. and, say, 6° F. below zero, about half a pint is necessary.

As early as 1896, twenty nine gas works in Continental Europe, principally in Germany, were using this method, introducing the vapor during only the hours of evening consumption; and from an advertisement in the German Gas Journal of December, 3, 1904, I notice that the method is now being used in no less than 193 different cities. I also have recent letters from Dr. Bueb's associate, William von Oechelhaeuser, of the gas works at Dessau, Germany, who assures me that the method is very successful and is being extensively adopted and used in Europe. This somewhat surprises me, on account of the high cost of the alcohol used, but Mr. von Oechelhaeuser explains that because of the absence of duty charges the cost of the alcohol in Germany is not prohibitory, as it would almost be in this country. For instance, at 60 cents per gallon, the present price of wood alcohol in Grand Rapids, ½ of a pint, or enough per 1,000 cubic feet of gas treated to prevent stoppages at 14° F., or over, would cost 2½ cents, while ¼ of a pint, or enough per 1,000 feet to prevent stoppages at temperature between 14° F., and –6° F., would cost 3¾ cents. With our present output at Grand Rapids, even if we should use this method during only the three hours of maximum consumption, the cost in below zero weather would be about $30 per day, and, as a matter of fact, on account of the extensive use of gas during the day time, it might be necessary, after all, to vaporize the aclohol during, say, 12 hours out of 24, which would make the cost about $65 per day. Of course, we would save the cost of the alcohol and labor now employed in freeing service pipes in the usual way, and would prevent the annoyance of our customers, which is the chief object to be attained; but this saving and result should, of course, be credited to each of the methods which

we have been considering. We have experimented with this method in Grand Rapids during the past winter, vaporizing in the holder outlet, during a portion of our coldest weather, ½ pint of wood alcohol per 1,000 feet of gas passing through it, with the result that we effected a very marked decrease in the number of freeze-offs; and we should probably have eliminated them altogether had we not been obliged to put our make of gas, during the hours of heaviest consumption, directly into the street mains, by-passing the holder. This gas, not having had the benefit of holder condensation, contained an excessive and abnormal percentage of water vapor, for the complete control of which the quantity of alcohol used was apparently insufficient.

Because of the fact that the gas enters the holder at a uniform rate throughout the 24 hours, but leaves it at widely varying rates, it seems that the proper location for the desiccating apparatus, whichever kind should be employed, would theoretically be on the holder inlet, rather than on the outlet, as much smaller, and therefore less expensive, apparatus would thus be required. In this event, however, it would be necessary to keep the water in the holder tank covered with some kind of oil that would prevent the absorption of water vapor by the dried gas. Although this could probably be successfully accomplished, I have treated this subject on the assumption that the apparatus would be placed on the holder outlet.

If I have made no error in the foregoing calculations, it seems probable that the quicklime method would be much cheaper than the alcohol method that has evidently obtained so strong a foothold in Europe. But, in my opinion, the air condensation method would be the cheapest of all, both in first cost and in operation. While my investigations and experiments have not yet gone sufficiently far to warrant my stating this as a definite and positive conclusion, it is at least evident, I think, from the foregoing discussion of some of the available and feasible methods of prevention, that gas companies should no longer jeopardize their own and their consumers' interests by following the present ancient and ineffective methods on the plea that there is nothing better.

Discussion.

The President—Gentlemen, this very thoughtful and painstaking paper is now before you for discussion.

Mr. McAdam—Respecting Mr. Butterworth's remark that "The difference being wholly due to the exposure of the gas supplied to the west side to the cooling effect of the air as the gas passed through the pipes on the bridges, as other conditions were the same throughout the city." I would like to ask him if any provision was made for taking care of stoppages in these bridge pipes by putting alcohol in them. The reason I want to know is that I think an excessive use of alcohol on these bridge pipes would have a tendency to saturate the gas to such an extent that it would prevent stoppages.

Mr. Miller—One result of drying the gas to a marked degree Mr. Butterworth did not consider at all in his paper. We had an experience in certain sections of our plant where it is supplied with compressed gas, or gas that has been compressed, that seemed novel. When we started the Algiers supply we decided to there use wet meters entirely, as we had a large stock of them, but we found out that we had to fill those meters about three times a week. The dry gas would take the water out of the meter so fast that it would shut off. Then we changed all the wet meters and put in dry ones, and in the course of 2 or 3 months we found those meters were all slow. An examination showed that the dry gas had taken absolutely all of the oil out of the leather, and the latter was passing gas just like a sieve. We found like conconditions in other districts in the city where they were getting gas coming through the high pressure system. While it may be a desirable thing not to have moisture or condensation in your meters, if you get the gas too dry you will have trouble with your leathers. To overcome this effect we put it up to the meter manufacturer to supply us leathers properly saturated, so that the gas would not take the oil up. But the situation was too serious with us, so we tried the scheme of oiling the diaphragms from the inside—taking the top off the meter and opening a valve, pouring the oil in the diaphragm, with some lampblack or graphite, oiling it from the inside and then draining it out. We got tolerably good results from that. Still that oil is taken out of the leather, and very frequently we find it deposited in the meter in the shape of condensation.

The President—I would like to ask Mr. Miller if he finds that oil deposit in the meter itself. Or is it carried on with the gas.

Mr. Miller—We found one case (where I can't recall) where nearly ½ pint of oil was gotten out of the meter, which I had identified in the laboratory as being the same oil as that we had used in the leathers.

The President—But you did not find that to be universally the case?

Mr. Miller—Oh, no; usually the leathers are left dry.

The President—And the oil had disappeared entirely?

Mr. Miller—Entirely.

Mr. Elbert—I made a few notes on Mr. Butterworth's paper, and I believe it will be the means of shaking up as it were those in the department whose duties require them to attend to this particular branch of the distribution of gas. In following out any of the various schemes as suggested for arresting the aqueous vapor, it looks to me as if it is shifting one of the troubles properly belonging to the distribution department to the manufacturing end of the business. This, however, might be a move in the right direction, if the suggested remedies will perfect an ideal preventative for the depositing of frost or condensation in the service pipe. I am of the opinion, however, it would not be an entire success. I refer more particularly to the drying by air in overground condensers. There is no doubt the aqueous vapor can be removed by exposing enough condensing surface to the gas in its passage from the holder to the street mains. This, however, would have to be of a sufficiently large surface to take care of the gas on a maximum load. This accomplished, and the vapor, reduced to water, freezes and must be removed again by heat, which at once spoils the effect of the condensing apparatus. At St. Paul we supply a large proportion of our consumers in the east and west districts through mains crossing on bridges. There are practically no frost cases in this territory, but the bridge pipes require constant attention during winter, and we are obliged to flush them with hot, salt water, pumping the same from the drips. This system or something similar no doubt would have to be applied to the air condenser at the works, and as stated above, spoils the effect desired. Again, I cannot see the use of doctoring all the gas with the danger of reducing the candle power, when only a small per cent of the consumers are ever troubled with frost. Our Company, from December 1st, last, to May 1st, this year, which covers all our frost cases for a year, had 2,714 complaints. A large number of these were duplicated, many times from one customer. Assuming, however, these complaints represented individual consumers, and comparing them with the total number, we would average about one complaint to 5½ consumers for the year, or each consumer requiring attention once in 5½ years, and owing to our latitude I do not believe any gas company would have any more than this. This does not look to me as being an "actual calamity" in failing to supply, partly or wholly, a consumer once in 5 years. The electric light, telephone or water companies cannot boast of better service, and as to the "citizen riding to and from his place of business swiftly and in a well heated car" lighted by gas, while it is an improvement over the horse car, the only constant comfort is the gas light; and many times during the winter months the public are seriously inconvenienced, and I believe the gas companies of to-day are supplying their consumers with less interruption than either of the above mentioned companies. Getting back to the service, if the average service does not freeze, why should any of them? The laying of a service in tar concrete as at Grand Rapids, is, no doubt, a good preservative to the pipe, but by no means a non-conductor of frost; on the contrary, is one of the best, as frost penetrates through a compact mass and remains longer than in a loose or disintegrated covering. The laying of a service at a great depth is but little better than a moderate covering, and will not remedy the frost trouble entirely, whether a winter is severe or not, and as a remedy I would say a service should never be less than 1¼ inch or larger, and when necessity occasions, should be laid in the center of a wooden box or tube large enough to form a dead air space, with the ends cemented or closed—this covering to extend through the wall. In no case allow a service to be levelled with stone or brick or extend through a wall without a box or tile around it. Now, as to the house riser and meter in exposed places, a dehydrator, a description of which appeared in the AMERICAN GAS LIGHT JOURNAL, March 7, 1904, could be used to good advantage. This is the Wrinkle of one of our members, Mr. F. C. Shepard, of Minneapolis, and I understand his Company has some 300 in use with perfect success. The device costs but a trifle, and the maintenance is very low, requiring only a little excelsior and broken up lime. Once a year these are changed and others substituted, the old ones being refilled. I have with me a full sized model with one side of glass for your inspection. This size will take care of 5 arc lamps, and for inside arcs in large numbers, such as are required in livery stables, warehouses, etc. The device is cylindrical in form, 12 inches in diameter, 24 inches long, set vertically and supplied with a by-pass that it may be easily removed and another inserted. Now, a word for the lamp post. Some years ago, having much trouble with keeping lamp post risers free from frost, I conceived the idea of setting every post to form a dead space. This was accomplished

by fitting boards tightly over the two slots in the base of the post, keeping the post free from dirt and the ell at the bottom entirely free of any covering, the top of the post being plugged with a wooden block with an inch hole for the rise pipe to pass through. I found this remedy almost perfect, and the posts required very little attention. In short, I believe that gas companies in general are not paying enough attention to the details of the service laying.

Mr. Waring—This paper does not take into consideration the water that leaks into the mains that run through low ground where the mains are laid in water. It seems to me where a great many run through the bottom of the river, there would be leaky joints admitting water which would destroy the effect of desiccation by resaturating the gas—it speaks also of oil on surface of water in holder tank. It strikes me that a variation of temperature would make the candle power fluctuate by the evaporation of the oil.

Mr. Mitchell—I believe the point has been brought out here, Mr. President, that we have troubles in our gas condensing, causing stoppages of the flow of gas to our consumers, and then we have an example here in New Orleans wherein the gas is dried too much. I think there is a point between the New Orleans experience and our other experiences where we can dry the gas so that it will not bother us one way or the other, and I think we can work and find that point. I believe Mr. Butterworth's idea is correct, and I think we can get to a point where we do not condense it more than necessary.

Mr. Wortendyke—One great thing against systems of desiccating gas is that it necessitates the introduction between the outlet of the holder and your city of some apparatus that may stop the gas from the entire city, and that would be much more serious than having a shut off for quite a number of isolated consumers. Although alcohol may cost more and not do the work quite so well, yet there is absolutely no way in which it can produce a shut off of the entire town.

The President—Is Mr. John R. Lynn in the room? Mr. J. M. Berkley? Mr. Jansen Haines?

Mr. Haines—Mr. Chairman, I have not prepared any discussion on this subject.

The President—One point that Mr. Miller brought up which is a little obscure to me is the removal of the meter oil by means of the dry gas. I can hardly understand how that is done, for the oil should disappear along with the gas. From the experiments we have made meter oil is not soluble in gas, but is soluble in oil that is condensed from gas. It seems to me that if his meter diaphragms bleached he should have found a combination of the meter and drip oil in these meters in which diaphragms were bleached. It was for that reason I asked Mr. Miller if he found the oil universally in the meters.

Mr. Miller—The oil was.

The President—That is what I would imagine.

Mr. Miller—I know this, that you use the correct term when you say bleached, because the leathers were almost white, and your expression of not understanding it was exactly the attitude that I was in when I went "against it."

The President—Is Mr. Gimper in the room? Gentlemen, if no one else cares to take part in this discussion we will hear from Mr. Butterworth.

Mr. Butterworth—In reply to Mr. McAdam, we did use alcohol in the bridge lines, at Grand Rapids, of course, in large quantity, but I do not believe that was the cause of the reduction in the number of freeze-offs in the territory supplied through them, because it was evident, from the frost found in these pipes, that here was where the moisture had already been deposited out of the gas. Mr. Miller's objection to the drying out of the diaphragms I think was answered by Mr. Mitchell. We don't need, necessarily, to dry the gas completely; we could dry it as much as is necessary to prevent these interruptions, and leave some moisture in the gas, so that the meter diaphragms will not necessarily be dried out. In this connection I would like to inquire of some of the gas meter manufacturers what their experience is with meters used by companies supplying high pressure gas, which, of course, is dry gas. I would like to have some meter man tell us what is the experience in that matter. Now, Mr. Elbert pleads that conditions in St. Paul are not bad, as they only had 2,700 difierent consumers affected by interruptions in their gas supply during the winter. I think that is very bad. He admits himself that some of these 2,700 had duplicate interruptions. Probably some of them had triplicate interruptions. If he had 2,700 different consumers out of gas in one winter, that probably means 4,000 or 5,000 individual interruptions in a town not having more than probably 15,000 or 16,000 consumers. I think that is very bad. No matter how much better we may be doing than possibly some other public service corporations, it is up to us to do still better if we can, undoubtedly. I think his device for preventing individual freeze-offs in those particular services which he knows to be bad and liable to make trouble, is all right; but it is only a makeshift after all. It is only a partial remedy. We don't know where these troubles are going to occur. They appear where we least expect them, and where they don't appear in one severe winter, they may appear in the following, although it is not so severe. That has been the experience of all of us. I would like to hear from the gas meter men as to what troubles they have as to the drying out of the meter diaphragms of a high pressure gas company.

The President—Is Mr. Gribbel present? Mr. McIlhenny, will you enlighten us on this subject?

Mr. McIlhenny—As far as the manufacturers of meters are concerned, I do not think the question brought up by Mr. Butterworth has been brought to their attention. There may be two reasons to account for that. One is that the distribution of gas under high pressures is of rather recent date; that is, it has not been practiced for more than a few years past, and the results if any have not made themselves manifest. I know of no complaint from meters used in measuring gas distributed under high pressure as to any deposit or otherwise in the meters. As to natural gas, which is, of course, subjected to high pressure, I would say it is as a rule perfectly dry, and I would say that conditions are ideal for meters measuring natural gas. I have seen meters opened that had been measuring natural gas for 10, possibly 15 years, and the meters internally were in as beautiful condition as they were the day they were originally made, a filmy oil which carries along with the natural gas being spread all over the interior of these meters. An evidence of the ideal condition under which natural gas meters work is seen also in the fact that there are practically no repairs required by such meters. I know of thousands of such meters that have been in use in single towns for 10 to 15 years, and there practically is no call for repair parts; that is, for natural gas which is free from sulphuretted hydrogen and which is not too close to the wells. When natural gas was first distributed, occasionally the gas was taken off in close proximity to the wells, and occasionally fine particles of grit accompanied the flow; but nowadays, on the long distance transmission lines, that grit is practically removed before it reaches the towns.

The President—Any further remarks on this subject?

Mr. Butterworth—The gentleman from Janesville spoke about the danger of an apparatus placed on the holder outlet interrupting the supply of gas to the city. I don't think there would be any danger. I don't see why a condenser could not be placed on the holder outlet that would be perfectly safe. As I suggested, they should be in duplicate, so that Mr. Elbert's objection also would be overcome. We could clean one while using the other.

Mr. McIlhenny—Mr. Chairman, I move a vote of thanks to Mr. Butterworth for his valuable paper. I would say also that this is a new line of thought, and we are particularly indebted to Mr. Butterworth for having brought it up. I believe that sufficient attention has not been paid in the past to remove difficulties found with gas outside the works. I know, in connection with the subject of meters, that if the excess of condensation be removed before it reaches the meters, the expense of meter repairs, and difficulties with meters, would be very largely removed by just such suggestions as Mr. Butterworth advocates. The great source of trouble in meters is condensation, and if we can remove that the meter will be there by benefited that much, and the company put to that much less expense. [Seconded.]

The President—A vote of thanks has been moved and seconded on behalf of Mr. Butterworth. I wish to say in this connection that this is a subject that could well be followed out, and cumulative papers could be written on it, until finally we would arrive at some definite device or system of preventing these stoppages. I think it would be well if Mr. Butterworth would consent to carry on his investigations and report again next year to the Association. Gentlemen, you have heard the question. [Adopted.]

The President then introduced Mr. J. B. Morehead, of Chicago, who read the following paper on

CALCIUM CARBIDE AND ACETYLENE:

By a carbide is understood a combination of a metal, or of an alkaline earth and carbon. The carbides are not to be confounded with the much more numerous family of carbonates, which contain oxygen in addition to the above and possess entirely different physical and chemical characteristics. Carbides do not exist in nature, but it is probable that those of almost all of the metals can be formed artificially by means of extreme heats, etc. Carbides of most of the metals have been produced and studied, but only two are of any commercial value, namely: Carbide of silicon, which is sold under the trade name of carborundum,

and is used as an abrasive, and carbide of calcium, which is sold as such and used as a source for the commercial production of acetylene.

Early in 1891 a plant was established on a water power in North Carolina, for the production of aluminum, the name of the Company being the Wilson Aluminum Company. As the process of the manufacture of metallic aluminum did not work out the Company engaged in the production of alloys of aluminum and copper. These were made by fusing a mass of copper in an electric arc furnace and then adding a mixture of aluminum oxide and carbon. When the mixture was subjected to the heat of an electric arc the carbon would take the oxygen of the alumina and copper would take the aluminum. As it was not possible to get the proportions just right in the furnace, it was the custom to make the alloys richer in aluminum than was required; then by drawing off a sample and making a hurried chemical determination of the proportions of copper and of aluminum, sufficient copper could be added to the bath to dilute the mixture down to the required proportions before it had cooled below the melting of copper. To avoid the necessity of reheating the mixture in the furnace the utmost dispatch was essential in the drawing and cooling of the sample and in its analysis, and so a small sample was drawn from the crucible, plunged into water and the analysis rushed through.

While the Company was engaged in the manufacture of aluminum alloys it was still experimenting with a view of perfecting the process for the manufacture of metallic aluminum. A series of experiments was instituted along the line of first producing metallic calcium by reducing lime with carbon. It was proposed to then use the metallic calcium as a reducing agent for the alumina to produce aluminum. On the first run for the purpose of producing metallic calcium to be used as a reducing agent, lime and coal tar were mixed in a caldron and put in the electric furnace. After a run which lasted for several hours on this mixture a sample was taken out of the furnace, and in accordance with the usual custom was placed in water in order to cool it for an analysis. Upon introducing a piece of the product of about 1 pound weight into the water, large volumes of gas were given off, and at first it was thought that the substance was metallic calcium, that the gas given off was hydrogen, and that the first step in the process of making metallic aluminum had been accomplished. Upon lighting the gas, however, it was found to burn with a heavy yellow flame and to give off quantities of soot which proved to be some rich hydrocarbon gas and not hydrogen, as was supposed. Subsequent analyses of the substance made at the Company's laboratory proved it to be calcium carbide. For want of gas analyzing apparatus at the local laboratory some of the carbide was sent to the University of North Carolina, and the gas was there analyzed and pronounced acetylene. Up to that time it was called "carbide gas." This first experiment was made May 4th, 1892. While calcium carbide had been spoken of as a chemical possibility and a laboratory curiosity for some time, and had possibly been produced by the use of metallic potassium, chlorate of potassium, etc., in very small quantities by various laboratory methods of interest only to the theoretical chemist, and while acetylene is of possibly older origin, they were in the same class which now embraces casium, helium, argon and other rare chemical possibilities known only to the theoretical chemist, whose business it is to know them, but which the average man possibly never heard of, certainly never saw, and to whom they do not exist at all.

When a process is discovered by which it is possible to produce a substance by tons, which before has been produced only by grammes, when a substance is made so that practically unlimited quantities are placed with the reach of all at a low price, where only before a limited quantity existed and that not on the market; when a substance becomes so common that its properties and appearance become familiar to all intelligent people, and its name a household word, where before its properties were matters of conjecture among a few experts and its name never heard outside of a laboratory, it may fairly be considered a new substance and its birth may be said to date from the date of the discovery which made these changes possible. Hence, it can be fairly stated that calcium carbide was discovered May 4th, 1892.

Calcium carbide is a crystalline body, hard, brittle and varying in color from almost black to brick red. Its specific gravity is 2.26. A cubic foot of crushed carbide weighs 138 pounds, and in weight, color and most of its physical characteristics is about like granite. If broken hot the fracture shows a handsome, bluish purple iridescence and the crystals are apt to be quite large.

Calcium carbide is insoluble in most acids and in all alkalies, it is non inflamable, infusible, non-explosive, unaffected by jars, concussions or time, and, except for the property of giving off acetylene when brought in contact with water, it is an absolutely inert and stable body. The transportation companies afford it the same classification for shipment that is given nails or spikes in kegs. Chemically it is described by the formula CaC_2, and has 62½ per cent. of calcium and 37½ per cent. of carbon. It is made by the reduction and combination in an electric arc furnace of a mixture of finely pulverized and intimately mixed calcium oxide or quicklime and carbon in the shape of coke. There is no adequate way of measuring the temperature necessary for the production of calcium carbide, and any estimate is merely approximate, but it is calculated to be from 5,000 to 8,000° F.

When we consider that the arc light people and the other electrical users employ carbon for their electrodes, because it is the only substance which will stand the extreme temperatures, and that the carbide makers themselves and also the carborundum people use carbon electrodes for the same reason, and further that crucibles of lime are used in gold and silver assaying, and for the pencils of the Drummond oxygen-hydrogen light on account of its extremely high fusing point, and then remember that carbide making is a purely thermal reaction and that these two bodies which are about the most infusible substances known to science are mixed pure—without any flux whatever—and driven into unwilling combination by virtue of sheer force and violence of the temperatures obtainable only in the crater of an enormous electric arc, it will be appreciated that the temperatures required and attained in this process are something simply terrific. The furnaces employed from 250–350 electric power each and produce about one ton a day. The output is crushed to different sizes and packed at the rate of about 50 tons a day in the two factories, and it is sold for $70 per ton at the works.

There are a few chemical uses for calcium carbides, but up to the present time they are in the experimental stage, and it can safely be stated that the entire use for calcium carbide is for the production of acetylene. Acetylene principally as a name is older even than carbide. It was first made by Sir Humphrey Davy in 1836. Its first production, too, was incidental to an attempt to produce metallic calcium from a mixture of calcium chlorate and charcoal. Acetylene occurs as a very small fraction of 1 per cent. in ordinary coal gas, it is produced when a Bunsen burner snaps back and lights at the mixer. It can be gotten by causing an electric spark to pass between carbon points in an atmosphere of hydrogen; it can be produced by passing hydrogen through a white hot carbon tube. In 1876, at the Centennial Exposition, Philadelphia, two gallons of alcohol were exhibited which had been made from acetylene extracted chemically from a great many 1,000 cubic feet of illuminating gas. All of the above processes of making acetylene are merely chemical possibilities. There is only one commercial way of producing acetylene, and that is by the mutual decomposition of water and calcium carbide.

Acetylene is a colorless and tasteless gas. When chemically pure it has a sweet, etheral odor, but in the commercial form it carries small percentages of phosphoreted and sulphureted hydrogen which give it a strong pungent odor. One cubic foot of acetylene weighs .069 pound; 13.85 cubic feet of acetylene weigh 1 pound. One cubic foot requires 11.91 cubic feet of air for its complete combustion. Acetylene has a gravity of .92 (air being 1) which is very nearly as heavy as air.

Acetylene contains 12 parts carbon and 1 part hydrogen, or 92.3 per cent. carbon and 7.7 per cent. of hydrogen. It is the nearest approach to gaseous carbon, and it possesses a higher candle power than any other substance which is known or recognized as possible in chemistry. It is an endothermic combination and possesses the extraordinary candle power of 240 candles for 5 cubic feet. It is soluble in its own volume of water, and in varying proportions in ether, alcohol and turpentine and to a very large extent in acetone. It liquefies under a pressure of 700 pounds to the square inch at a temperature of 70° F. The pressure necessary for liquefaction varies directly with the temperature up to 98°, which is the critical temperature for acetylene, beyond which temperature it is impossible to liquefy the gas at any pressure.

When calcium carbide is brought into contact with water, the calcium of the carbide, which possesses a greater affinity for oxygen than the hydrogen which forms a part of the water does, robs the hydrogen of its oxygen and forms lime and thus sets the hydrogen free. At the same time that the calcium of the carbide combines with the oxygen of the water, it liberates its loosely held carbon, and this carbon of the carbide and the hydrogen of the water being nascent, and having nothing else with which to combine, unite and form acetylene. The primary reaction is the formation of lime with the formation of acetylene incidental, but as wheat may sometimes be threshed for the chaff, so in this instance the by-product is of value and is saved, while the body, which furnished the energy for the reaction, is thrown away in the water in the form of slug.

Sixty-four pounds of calcium carbide combine with 36 pounds of water and produce 26 pounds of acetylene and 17 pounds of residue. The residue is very pure, slacked lime, and may be used for whitewashing, mortar making, fertilizing, disinfecting, or any other purpose for which lime is ordinarily employed.

Chemically pure calcium carbide will yield at 70° F. 30 inches, mercury, 5.83 cubic feet acetylene per pound of carbide. Commercially pure carbide is guaranteed to yield 5 cubic feet of acetylene per pound and usually exceeds the guarantee by a few per cent.

The reaction between calcium carbide and water, and the subsequent slacking of the calcium oxide produced, give rise to considerable heat, which is the principal foe of the generator designer. This heat from one pound of chemically pure calcium carbide amounts to sufficient to raise the temperature of .49 of a gallon of water from the freezing point to the boiling point.

While acetylene is not affected by any degree of cold, temperatures in excess of 536° F. cause it to polymerize or to combine with itself, to double up rather than to break up, and changes of great chemical complexity begin to take place in the structure of the gas. If the acetylene is once raised to this temperature no amount of subsequent cooling will undo the damage which it sustains.

All acetylene will contain traces of oxygen, hydrogen, ammonium, sulphur and the two hydrogen combinations mentioned above. With the pure materials used in the manufacture of American carbide purification of the gas is not necessary, especially if the gas is generated in a wet machine where the gas is to a very great extent scrubbed of its sulphur and ammonium compounds by bubbling through the water and lime in the generator. Such, however, is not the case with carbide of foreign manufacture, which contains phosphoreted hydrogen in sufficient quantities to form a white haze around the burner where the ventilation is insufficient for the removal of this. The gas may be scrubbed for the removal of these impurities with any kind of a strong oxidizing agent, such as bleach, or better with chromic acid which forms the base of most of the chemical purifiers on the market.

Owing to the extreme richness of acetylene, burners for its consumption are unique in design. They are built with a view to supplying an amount of air which with other gases would be in large excess. They are made by the employment of two Bunsens which inject air along with the gas, from which the streams of gas from the two arms enveloped in air impinge on each other and form the luminous part of the flame in the air, and of contact with any part of the burner.

When it is considered that the only thing necessary for the production of acetylene is the simple contact of calcium carbide and water, and that the necessary and inevitable result is the immediate evolution of quantities of acetylene varying only in direct proportion with the quantity and purity of the two bodies concerned in the reaction, it would seem that very little scope was afforded to the mechanical ingenuity of the inventor in devising means by which the necessary contact between the two interacted bodies can be brought about; but a glance through the patent files of the last 5 years, through the advertising columns of the trade journals, or the list of over 100 generators—all different, which have been passed by the various boards of under writers, will prove that such is by no means the case.

Unfortunately a number of designers of acetylene apparatus, who while undoubtedly possessed of a high degree of ingenuity and mechanical skill, had but little idea and less definite knowledge of the properties of one of the bodies with which they were dealing, and as a result many generators were arranged with little regard to safety, and while they did generate acetylene, they made the gas in anything but its purest form, and many gave a far smaller yield of gas of probably a lower candle power per unit of carbide consumed than could have been gotten from the same carbide by some machine otherwise constructed upon more rational principles. The weak points in the early designs soon made themselves evident by leaks, by unsatisfactory light, by high cost for light, and in some instances by explosions.

There are two types of generators; one in which a varying quantity of water is dropped onto the carbide, the other in which the carbide is dropped into a large excess of water. The first class may be subdivided into the machines in which the carbide is dipped into the water and then withdrawn, or in which water is caused to flood a mass of carbide and then to recede. Owing to the large amount of heat generated by the reaction, and the susceptibility of the acetylene to heat, the first, or dry type, is confined to lamps and to small machines.

There are two ways of getting rid of this heat of generation, and the degree of success attained in a very large measure determines the success or failure of the generator.

The first is by dissipation into the surrounding air, and the second is by absorption in water. Dry machines depend upon the first principle; wet machines upon the second. A few small machines such as bicycle and automobile lamps, etc., depend upon the first principle; all large machines upon the second. The underwriters require provision for one gallon of water for every pound of carbide, and as it requires only 0.56 of a pound, or a little over ½ pint of water for the chemical reaction, there is ample water left for the absorption of the heat, and the possibility of danger, or rather of annoyance and expense from overheating, may be considered as out of the question with any approved acetylene generator of the wet type now on the market.

Acetylene possesses very great enriching qualities for ordinary gas. Each 1 per cent. added to ordinary gases will give an increase of 2 candle power, and it is practicable to attain a higher candle power in this way than is possible by any other means, but in price acetylene cannot compete with oil, gasoline or cannel coal, as an enricher for candle powers within their range.

Acetylene contains 1,685 B.T.U. per cubic foot as compared with 1,000 for natural gas and 600 for coal or water gas. And while the illuminating value of acetylene is from 10 to 15 times that of ordinaay gas, excepting for small uses, acetylene is neither a power, a heat nor an enriching proposition.

At the present state of development of the acetylene industry, and of the art of calcium carbide manufacture, this gas will not compete with coal gas or water gas, or with electricity as supplied in our cities. It has a field of its own, in which field it is unique and fills a long felt want. For isolated domestic or commercial lighting, such as farms, drug stores, lodges, churches, groups of houses, factories, summer resorts, and in towns and cities of less than 5,000 inhabitants, etc., it leaves nothing to be desired. The modern generators have been worked out with great skill and they are very satisfactory. They have been passed upon by the Board of Fire Underwriters, who consider them safe enough to be given a lower insurance rate than is accorded to kerosene or other forms of illumination which they supplant.

There have been accidents with acetylene, but when it is remembered that of the machines now in use, operated for the most part by people with a minimum of mechanical ability, and an absolute ignorance of gas making, it will be granted that the proportion has been very small, and in almost all instances the accidents which did occur have been the result of the gross carelessness or of the needless ignorance of the persons having the plants in hand, and in almost all instances were the results of the old combination familiar to all gas men—the fool, a leak and the light.

Acetylene may be stored under pressure for railway and other portable lighting, and it may be absorbed in acetone and used for the same purpose. It is so used now under the first system in about 300 cars now being lighted under the well-known Pintsch system of gas storage. The second system is being experimented with and is making quite some headway.

For lighting towns too small for water or for coal gas, or for those parts of larger places not now reached by the regular mains, acetylene is very well worth the atten tion of the gas fraternity. Acetylene offers the one practicable and profitable method of lighting towns of less than from 3,000 to 4,000 inhabitants. That it is successful in lighting the smallest as well as the largest of these towns is shown by the fact that of the more than 200 acetylene plants now in operation, about 75 per cent. are in towns of between 500 and 2,500 population.

The principal reasons for the success of acetylene in this field are the low first cost of the plant, simplicity of the production, small cost of maintenance and repairs, and the economy of the light furnished. Such is the high candle power of acetylene that only one-tenth of the volume of this gas is required to produce a given candle power as compared with the volume necessary when other gases are used. This means that in a town where ordinary illuminating gas would require a holder of 10,000 cubic feet capacity to supply one day's requirements, a holder of only one-tenth the size would be necessary if acetylene is used. The same reasoning applies to the size of mains.

Acetylene being a true gas, and containing no condensable constituents, it is not affected by temperature changes within atmospheric limits, and hence it is not necessary to lay mains deeper than just sufficient to protect them from cart wheels or other mechanical harm. It is possible to install an acetylene plant at considerably less than the cost of installing a plant for any other kind of gas, or to install an electric light system.

By simplicity of production is meant the simple manner of generating the gas by the mere process of bringing carbide into contact with water. Neither expert labor nor the services of a superintendent is required. A man of ordinary intelligence, after a little instruction, can success

fully operate a town plant and only about 1 or 2 hours' labor each day are necessary to take care of an average plant in a town of from 500 to 3,000 inhabitants.

While automatic generators have been used for making and supplying gas to mains direct, the use of such method is not advisable for obvious reasons, and the largest and most successful systems of town lighting are those employing storage holders large enough to supply the maximum consumption of any 24 hours. The generator used by the United States Government at Fort Meyer, Va., and Chickamauga Park, Ga., two large acetylene systems, and by the majority of the largest town lighting plants in this country, is a heavy cast iron and boiler plate apparatus which feeds a limited amount of carbide into an excess of water by means of a screw conveyor, the conveyor being driven either by hand or by a small water motor.

A feature that is unique in producing acetylene is that the cost is not dependent upon the quantity of gas generated, as no fuel or materials other than carbide and water are required. Acetylene may be produced in small quantities at quite as low a cost as it can be made in large volumes. Statistics gathered from various acetylene plants that have been in operation for one or more years show that plants properly built earn from 6 to 30 per cent. on their cost, while the gas is sold at a price that is quite satisfactory to the consumers.

The growth of the acetylene town lighting plants has been phenomenal. In 1898 there were 4 plants; in 1899 there were 8; in 1900 there were 30; in 1901 there were 39; in 1902 there were 60; in 1904 there were 202, and since the beginning of the present year a number of new ones have been started

In addition to the town lighting plants there are now in operation over 80,000 isolated plants supplying from 10 to 2,000 burners; there are bicycle and automobile plants without number, and there are several thousand table lamps supplying a magnificent reading light where it is not obtainable otherwise.

As to a supply of carbide, The Union Carbide Company has two large works, one at Niagara Falls, N. Y., and one at the Sault Ste. Marie, Michigan. It has a warehouse for the distribution of the product in Portland, Oregon, and one in Portland, Maine. It has one in Minnesota and one in Mississippi. It has one in Carolina and one in California. It has one in Maine and one in Texas. It has six on the Atlantic, two on the Gulf, three on the Pacific, two on the Mississippi, two on the Lakes and at least one in almost every State between.

I brought some apparatus which was loaned me by different dealers in these lines around the city, and here are some samples of the different commercial sizes of carbide. The different types of generators require different sizes of carbide. The large ones, which feed the water on the carbide, use this coarser crush. The coarser the carbide the better, as it is possible to get a little more gas out of it. Those which require the flowing of the carbide into the water have to have the smaller sizes to keep it from arching. The carbide runs in these different sizes, from the sizes required for the largest generators down to this size, which is about like rice. This small size is used in these lamps and in several other types of machine which move the carbide to the water, instead of the water to the carbide. These different sizes are for different purposes, the quality is the same. These are automobile lamps. They were loaned me by the Hind-Walker Manufacturing Company of Chicago, who deal in them in this city. Some of these have the acetylene generator in the lamp, and some have the generator apart and connected to the lamp by hook. That is a bicycle lamp, this a portable table lamp. These are probably the smallest gas plants in existence. This is one with the generator in the back. With these table lamps, the bottom is filled with water and the top with carbide, the gas is made by introducing the carbide into the water, a diaphragm here controls the flow of carbide automatically to the burner. These use this form of carbide. There is a good many thousand of them out. There is a diaphragm there, a valve here, a constricted place in there, and the valve is hung by means of a stem to the bottom of this diaphragm. The valve is like a mushroom, and the carbide lies above. Here is the water in the bore. When you start it you generate gas which fills the receptacle and raises the diaphragm. When the diaphragm raises it shuts off the carbide from the water. There is a little governor in there which maintains an even pressure of gas at the burner. As you burn the gas out the diaphragm collapses, as it comes down it opens a little space between the valve and the seat, and the carbide flows down in here. As the gas is generated it fills the diaphragm, and raises it and closes valve again. These two lamps are practically identical. This is a little different in the type of burner. These burners that I mentioned—I have some here, showing the different designs, some of them have as many as six different flames—were loaned me by the D. M. Steward Co., of Chattanooga. This is probably the smallest gas plant in existence. It is an entire gas works. You have got your material there, it does its own labor, and here is your system of mains, from here to there; here is your governor and valve house; here is your consumer. You have no trouble from electrolysis or labor. If I can answer any queries I shall be glad to do so.

Discussion.

The President—Gentlemen, we have certainly listened to a very interesting paper. In this connection, I would say that while Mr. Morehead's method of speaking would not tend to make any one believe that he was from the South, still he is from North Carolina, and is the man who discovered carbide. I would like to have a little discussion on this subject. Mr. Pratt.

Mr. Pratt—Mr. President, I have prepared no discussion myself, but Dr. Harrop, the chemist of the Milwaukee Gas Light Company, handed me this just before leaving Milwaukee to have it read at the close of the paper. I will read it:

Comment by Dr. Harrop.—I do not wish the following to be taken as a criticism of Mr. Morehead's paper in any sense, for I know that he is a pre-eminently able chemist and a first class electrical engineer, and as he has been identified with the carbide industry since he installed the original electrical furnaces at Niagara Falls he must understand this subject thoroughly. These notes aim to bring out, in the discussion, information additional to the argument so cleverly made for acetylene in the paper proper. (1.) The Carbide Company seeks the best lime producing stone and the coke with the lowest ash content, but even then the carbide must fall considerably short of 100 per cent. CaC_2. Pure CaC_2 may generate 5.83 cubic feet of acetylene, and it has been stated that commercial carbide may not generate over 5 cubic feet. What per cent. of the average selected carbide put upon the market is CaC_2? Again, can free carbon or uncombined calcium oxide occur in commercial carbide and how much? (2.) The figures commonly given for the heating power of acetylene range from 1,400 to 1,555 B.T.U. per foot. Mr. Morehead gives 1,685 as the correct figure; this is very similar to that published by Prof. Vivian B. Lewes in his volume "Acetylene." Does Mr. Morehead know that this is the correct figure of his own experience, and it is based on the anhydrous gas. (3.) Is the gas sent out from the best form of generator anhydrous? If not, what per cent. of water vapor does it contain? (4.) The paper states very clearly that carbide will not detonate from any kind of blow or concussion. It is a matter of public knowledge on the other hand that compressed acetylene occasioually does explode—one serious case was reported from South Chicago quite recently. Since the deportment of acetylene under pressure has been studied very thoroughly and in a scientific manner, it would be well to put a summary of these facts on record in the discussion.

The President—Can we hear from some other gentleman on this subject?

Mr. John D. McIlhenny—I would like to ask Mr. Morehead at about what price the gas is sold in the small town plants that he mentions?

Mr. Morehead—The gas is sold by the 100 cubic feet, not by the 1,000. It ranges from $1 per 100 to $1.50 per 100, that is, $10 to $15 per 1,000. The meters which are used for this have one dial more than the ordinary meters; otherwise they are the same. The ordinary meter does not read closer than 100 feet, which with acetylene would be $1; with ordinary gas at $1 per 1,000 it would be 10 cents So they speak of it as $1 a 100, or dollar gas, or a $1.50 gas.

The President—Mr. Lynn.

Mr. John R. Lynn—I notice that the author has placed the heat units of coal gas at 600. I think you will find that a good coal gas comes about 650. Furthermore, in a comparison of the holder capacity that would be required, the author of this paper seems to have lost sight of the fact altogether that the greater quantity of the artificial gas sold in the country is sold through the appliances where heat units, and not candle power, are of the greatest importance. I think the main thing for us to consider is that calcium carbide would probably cost about $80 in ton lots, would contain 750 pounds of carbon, would produce a little more than 800 pounds of acetylene—about 11,000 cubic feet—at a cost of approximately $7.20 per 100. When we consider that the greater part of our gas goes through appliances, as I say, where heat units constitute the thing to be considered, I don't see where the gas companies can gain in any way by using calcium carbide or acetylene as an enricher or any other way.

Mr. Forstall—Taking up this comparison between the holder capacity required for acetylene and coal gas plants, I am afraid Mr. Morehead, like other electrical engineers, has forgotten there is such a thing as a

Welsbach mantle. He has compared the acetylene flame at its maximum capacity of 240 candles for a 5 cubic foot consumption with the ordinary flat flame of carburetted water gas, of about 24 candles. Now, I think it is pretty safe to say that the ordinary acetylene flame, as used in practice, burning abont ½ cubic foot per hour, does not give light at the rate of 240 candles for 5 cubic feet; in other words, that the ½ cubic foot flame does not give 24 candles. It is also pretty safe to say that the man who burns coal gas or carburetted water gas in such way as to get less than 25 candles per cubic foot is wasting his money. So that instead of the amount of gas required for a given amount of light, taking it on the light basis, being 10 times as much with carburetted water gas or coal gas as it is with acetylene, it is probably not more than twice as much, so that you cannot reduce the capacity of your holder to one-tenth in an acetylene gas plant. As far as the street mains are concerned the difference is still smaller, because in distributing ordinary illuminating gas we are distributing gas of $\frac{4}{10}$ specific gravity, while in distributing acetylene we are distributing gas of $\frac{9}{10}$ specific gravity. Now, in regard to the man of ordinary intelligence, successfully operating a town plant on only about 1 hour or 2 labor each day. I have seen illuminating gas plants which were run on that basis, and I bought one of them a little while ago for less than its scrap value. The point that I wish to make may not be apparent. It is not that the time should be occupied in operating the plant, but it should be occupied in finding somebody to use your gas.

Mr. Morehead—As a matter of fact the Welsbach burner, even if it burns coal gas, will take from 3 to 4½ feet an hour, while with this the burners which are there are burning ½ foot an hour, and in that respect you do use less gas. On the other hand, you can burn acetylene in a Welsbach and get practically the same increase in light. It is only fair to say, however, that the Welsbachs for acetylene up to this time are not thoroughly satisfactory. The flame temperature of acetylene is so high that they don't give the same satisfaction which the open-flame burners do; but there are a number of Welsbach burners using acetylene that are fairly satisfactory. As for the specific gravity, of course, it is twice as heavy, and the gas is rather sluggish just in that proportion, and the mains would have to be somewhat larger than they would if you shifted the same amount of coal gas at the same pressure but at a lower gravity; but it is not anything like 10 to 1 which is the proportion in candle power. Figured in an open flame, as Mr. Forstall very properly says, perhaps ½-foot burner does not give the proportion of 240-candle power. Nor does a small, flat flame, coal gas burner give the proportion of 24 candles, or 18 candles, or whatever a gas company says the gas is that it sells? There is more gas used in flat-flame burners to-day than there is in Welsbach (cries of "Oh, no"). Well, I think that there is; you cannot argue with me on that point.

Mr. J. R. Lynn—Did I understand the gentleman to say that with a mantle light there would be the same proportionate increase with acetylene. The statement will not apply, because there is not the same difference between the primary candle power and the number of heat units per cubic foot that you can get from it. It cannot apply. It is a chemical impossibility.

Mr. Forstall—I only want to say in response to Mr. Morehead's suggestion as to the candle power of gas not holding out on a flat flame burner, that I always tested the gas I made with a flat flame burner.

Mr. Morehead—And he tested it under 6-tenths pressure in a photometer room, without any air draft, and probably changed his photometer burner about every six weeks; if he did not, he should have so done. As far as the candle power with a Welsbach burner varying directly as the heat unit content of the gas is concerned, I beg to differ with the gentleman. The flame temperature of a gas has a great deal to do with the candle power that you get from a Welsbach burner, irrespective of the heat units. You can take blue gas, which has only from 300 to 350 heat units per cubic foot, but which has an enormously high flame temperature, and get very much more than half the heat units out of it that you would get out of a coal gas or a water gas with twice that number of heat units, or with natural gas, which has a very low flame temperature. You could not get anything like 3 times the the candle power per cubic foot out of natural gas with 1,000 heat units that you could get out of blue gas with 300 heat units, for the simple reason that it is flame temperature rather than the heat units—not alone, but along with the heat units, which determines the candle power when the gas is burned with a mantle. Another gentleman spoke of the heat units in acetylene. That was determined in Prof. Lewes's laboratory in Greenwich, near London. I did the manipulation of the calorimeter. That is not the reason, however, that it showed so high, but I was there with Prof. Lewes at the time. We did a great deal of work on this in London in 1896; 240-candle power can be obtained from any acetylene if you get all the air out of it. Of course, commercial acetylene contains a little air, sometimes 2 to 6 per cent. But you can get that out without any trouble.

Mr. Norris—Mr. Chairman, can Mr. Morehead give us the actual candle power ½-foot per hour acetylene flame? It has been alluded to as being something under 24 or 25 candles, but how much is it actually?

Mr. Morehead—It varies very largely with the gas and the condition of the burner. The ¼-foot or the 1-foot burner of the Bray type and of another burner made in this country, will give you the actual 48-candle power per foot, which is 240-candle power for the 5 feet. The ½-foot burner, just as if you got any burner that is small, will give you less in proportion. Instead of giving you 24 candles it will give you 20 to 22. I have frequently gotten that with them on the photometer. On the photometer, with the 5 feet of gas that you use, you use a burner consuming 5 feet. If you had a smaller burner, which burned only 2½ feet, you would not get half of the candle power that you would with the 5-foot burner by a very great deal, and the same thing applies to these ½-foot burners which I have burning here. There are also some 1-foot burners there. You could not tell the difference by looking at the burners, but it is very apparent when you see the flame and its light.

Mr. Doty—Mr. President, I had the opportunity of being associated with Mr. Morehead at the Exposition at St. Louis last year, and I must confess that I became a great admirer of his knowledge of acetylene. The rest of the jurors, and a great many of the gas men I am sure, had no conception of the importance of the acetylene industry in this country, and this is equally true of the importance of the acetylene industry abroad. I think I am correct in stating that in France alone something like 40,000-horse power is daily employed in the manufacture of calcium carbide. I have not the figures for the American production, but I know Mr. Morehead has them at his fingers' ends, and I think if he would express to the members the amount of horse power daily used in the United States it would carry a very strong and lasting impression in their minds; and, I understand, the use is growing daily, not as some of the gentlemen seem to think, that acetylene is a competitor of the ordinary city gas industry; rather it is a helper, an introductory means of developing the gas business when the city grows, and therein lies to my mind one of the most important advantages to our industry of the acetylene industry. They don't need any help from us at all, but we will get a great deal of assistance from them by the introductory or educational work they are doing. I would like to ask Mr. Morehead what amount of horse power is being used daily in the United States, and whether he can give figures for any of the countries beside France.

Mr. Morehead—There is in use in this country between 20,000 and 40,000-horse power in the two plants, and with the exception of some of the very large traction companies we use more electricity than any industrial concern in the United States, I don't know but in the world. Of course, in New York the Manhattan and some of those big electric railroads employ more electricity and more power, but for any industrial purpose we use more electricity than any of them. As Mr. Doty has said—he brought up the question—there are a great many towns which cannot be lighted by coal gas or water gas, because they are too small. The question comes up. I have heard of it very often. A man comes to some gas engineer and says, "We want to know whether we can put in a gas plant at this place." The engineer asks, "How many people have you?" and he replies, "Two thousand," "Fifteen hundred," "Three thousand." The Engineer says, "It won't pay." Now, it is free to confess that in a town like Chicago, or St. Louis, or any town of large size, you could not use acetylene, and in the small towns you cannot use water gas or coal gas, but you can use acetylene in those places, and it has a field to itself. It is very well worthy of the attention of the gas engineering fraternity for those places which are not covered by the other fields. Of course, the small generators, of which there are about 80,000, into which you put carbide like you put coal in a stove, hardly apply to the gas engineering fraternity, that is, people who are in the consulting engineering business for gas, but in the smaller towns these plants pay a very good profit. They don't require a great deal of investment, and they are very well worth the attention of the gas people. I don't think the gas fraternity have ever had the matter brought to their attention to the extent it merits.

Mr. Doty—How much horse power is used abroad?

Mr. Morehead—About the figure that you said in France. There is a trust there which controls the rest of the power. There is none in Austria. I think there is about 7,000-horse power in Germany and about 10,000-horse power in Sweden. There was a plant in England which used, I think, about 500-horse power, but that has been shut down

now. One little plant in South America is using about 400-horse power.

Mr. Doty—In France more generally?

Mr. Morehead—In France more than any other. On the side of the Alps next to France they are using more acetylene than in any of the other European countries. There coke is very bad. It carries a great deal of phosphorus, which necessitates the scrubbing of the gas. Very large amounts of acetylene are used in train lighting. The imperial railroads in Germany and in Austria are lighted with a mixture of it and with the gas pure, and that is one of the largest uses. A great deal of carbide is manufactured in Switzerland.

Mr. Doty—I should like to ask Mr. Morehead if the generators made by the foreign manufacturers would pass the underwriters' rules for American practice?

Mr. Morehead—They would not. The generator manufacturers are here rigidly held. They have a set of instructions which they require for every generator, and if the generator passes that all right, if it does not it does not. They have turned down a great many generators. Abroad there is a lot of hand work; you control the generator by hand. Labor is very cheap there. The generators are not as well made as ours, and they don't have the safety appliances which the underwriters here require. Now here the underwriters require a gallon of water to the pound of carbide. It is not necessary but it is on the side of safety. A half pint is required for the chemical reaction, but they require a gallon, so as to be on the safe side. Abroad they don't require it. On that one point alone none of the foreign machines would get through the underwriters' examination on this side, which is a great point for safety of the American machines.

Mr. Doty—Would you consider that the state of the art in manufacturing acetylene appliances is ahead in this country of the foreign countries?

Mr. Morehead—We are very much superior to them. In fact, we are sending a lot of our apparatus over to them. We get everything that they do. When anything new comes out we get samples of it here. We are in touch with the progress there, both in the manufacture of calcium carbide and the utilization of it. In the lamps, generators, stoves, engines and things of that sort, they have not anything to teach us.

Mr. Miller—What about the use of acetylene in mechanical operations? I believe there was an installation brought to the World's Fair for the use of acetylene for some mechanical operation; welding, or brazing, or something of that kind. I would like to know what advance has been made in that direction.

Mr. Morehead—Acetylene has an exceedingly high flame temperature in addition to its heat units. For welding purposes, and in the attainment of temperatures which you cannot get by means of other gases, it has a field, and it is used to quite an extent. A man in Ohio is making rubies with it. You can fuse almost anything. You can melt platinum with it. By taking acetylene and oxygen you can get temperatures almost up to the fusing point of lime. Now, you cannot get those temperatures with ordinary gas. When it comes to heating a house or to cooking, the expense would forbid its use on a large scale. You cannot get heat with an electric furnace for anything like the same cost that you can get it with coal. But coal would stop at 3,000°, while an electric furnace would go to 6,000°. If you get out of the range that you can obtain with the other gases, acetylene is cheap.

Mr. Haines—What proportion of calcium carbide is used for automobile lighting, and what for house lighting. The figures have been given for France, I think, of 40,000-horse power. I would like to know about what proportion is used there and what proportion is used in this country.

Mr. Morehead—It is almost impossible to say. The automobile size of carbide or the size which I have here in my hand, is used for a number of generators, and the proportion used during the year for each month varies enormously with the time of year. As you naturally see, in the winter there is not much used, in the summer there is a great deal. So that I am really unable to say just what proportion is used for generators and what for lamps. In the bicycle days a great deal was used. They required a special size. That was before these lamps came out, and it was before they used that size of carbide in generators, and we were able to keep account of it, to know. I don't happen to remember the figure at the moment. But now these sizes are all mixed up, so that a man buys 100 cwt. of carbide, and there is no knowing whether he is going to use it in an automobile or for lighting a church, a drug store, a house, a lodge or a summer resort.

Mr. John R. Lynn—Mr. President, I should like to ask Mr. Morehead if any acetylene gas is used from these isolated plants for fuel purposes.

Mr. Morehead—Quite a little of it is used for fuel purposes. There are stoves for it, and hot plates. I wish I had brought some of them here. They are precisely similar in appearance to the ones with which we are all familiar. They work very satisfactorily. The cost would forbid their use however on a very large scale; on a small scale, for a small amount of cooking or something of that sort, why, you could use them, but it gets rather expensive if you use a great deal of it.

On motion of Mr. John D. McIlhenny, a vote of thanks was tendered to Mr. Morehead for his excellent paper.

(To be Continued.)

Calorimeter Testing of Gas.

[A paper read by M. A. Lecomte, at the last meeting of the French Society of Gas Lighting.]

In the early days gas works were simply bound to purify the gas well and to supply it at a given pressure. Later on came the lighting power and the corresponding consumption per hour; and in 1845, Arago, Fresnel and Mary were consulted as to the relation between the lighting power and the consumption of the three forms of batswing burners then in use in Paris. In 1862 the whole question came before Dumas and Regnault, since it had been found that the batswing burners in question did not give the light expected; perhaps because the coal used had changed, the Commentry coal used in 1845 having been exhausted before 1860. The result was the introduction of a wider slit, which enabled the batswing burner to give the required light with the gas then available; and also the complete codification of the rules for testing and also for purifying gas. The position at present somewhat resembles that of the year 1860; the coal now obtainable does not give as good results as formerly, and the increased yield per ton makes it still more difficult to obtain gas consuming only 105 liters per carcel. But incandescent mantles have now greatly diminished the importance of candle power, and as far back as 1893 Aguitton proposed to do away with it altogether as a criterion and to have regard only to the heating power.

Now, in estimating the heating power there are 3 main methods: (1) Burning the gas at constant volume in a closed chamber immersed in water (Berthelot's bomb, Mahler's shell, Witz's eudiometric bomb); (2) burning gas at a constant pressure in a space maintained at a constant temperature (D'Arsonval's, Mathias', Hartley's, Junkers' calorimeter, and the calorimeter the subject of the present paper); and (3) burning gas at constant pressure in a burner of known size under a calorimetric vessel which absorbs a known proportion of the heat developed. Of these the first are said to be the most exact; but they are too scientific, they need oxygen under pressure, and they require a good deal of time for each test; and the degree of precision is diminished by the difficulty of filling the bomb with the gas to be tested and bringing the pressure in the bomb to the atmospheric without allowing any air to get in; operations which may easily lead to a mistake of $\frac{1}{16}$ per cent if the pressure inside the bomb be off the atmospheric by 0.4 inch of water. The second method is criticized, as presenting difficulties in getting a current of water and one of gas well adjusted, as presenting extra chances of loss by radiation, and as giving results too low by reason of imperfect combustion. The third method is purely empirical, for practical comparisons, but is capable of doing good service and of giving useful results rapidly. At the meeting of the Société Technique in 1903, M. Delahaye pointed out that the second might give results differing by 2 per cent., according to the relation between the stream of water and that of gas. This set the author working at the elimination of these defects from the second of the above three systems. In this system the heat produced is taken up as and when it is produced, so that the flame burns in a region of constant temperature, and the amount of heat produced is calculated from the amount of water which has run through the apparatus, together with the actual rise in its temperature. This idea is due to D'Arsonval, and the author has modified his apparatus, which is really a miniature bath heater in which the consumption of gas is so far kept down that the efficiency becomes as nearly as possible 100 per cent. and in which condensation of liquid products is at the same time not allowed to affect the result. Radiation is kept down by using polished or preferably nickeled metal; and losses by convection by reducing the conduction of heat. The heat lost by convection is proportional to the difference of temperature between the hot body and the surrounding air, and the less this is the less heat will be lost. Instead of having one current of water and one space traversed by smoke tubes, as in D'Arsonval's apparatus, the author uses two cylindrical spaces. The outer of these remains relatively very cool, and the losses of heat by convection are thereby greatly reduced.

The apparatus used by the author is shown in Fig. 1. Two concentric cylindrical spaces, *A* and *B*, are connected with one another by 6 mouthpieces *C*, and the whole is further jacketed by *K*, nickel plated, and containing air which does not circulate. Water enters by *D*, any excess going through *E* into a vessel with overflow siphon *F*; a cylindrical expansion at *G* receives a thermometer T_1; then the water is branched in definite proportion through the tubes *a* and *b* to the two spaces, *A* and *B*, to meet again in a little collector *H*, where there is another thermometer T_2. Finally the water goes out by *I* and *J* to a vessel in which it can be weighed. The stopcock *N* is adjusted so as to keep the thermometer T_2 at any desired elevation of temperature. The combustion products from the burner *L* ascend in *A*, descend between *A* and *B*, and escape through apertures in *M*. Little tubes *ac* and *bc*, discharge the condensed water from *A* and *B*. The quantity of water passing through *A* is less than that passed through *B*, and as it leaves *A* the water there is hotter than that which comes from *B*. In *B* a larger bulk of water is used in finishing the cooling down of the products of combustion. For example, temperature at T_1, 14.8° C.; at the top of *A*, 43.1°; at the top of *B*, 22.5°; at T_2, 31.2°. The average temperature of *B* was in that case half the difference between T_1 and the top of *B*, that is, 3.85° above the atmospheric; while if there had been only the space *A*, the average temperature would have been 8.2° above the atmosphere. The chances of loss of heat are thus greatly reduced.

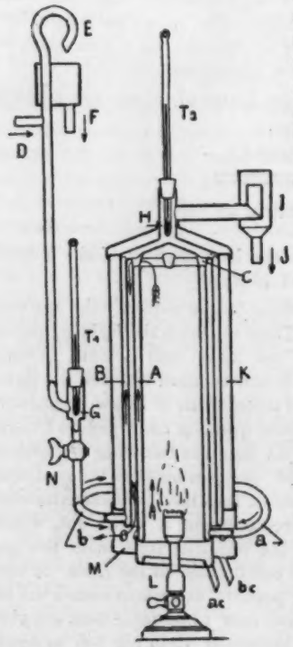

Fig. 1.

The meter is first watched, in order to make sure there are no leakages. The water is turned on at *D* and then at *N*; then the burner is lit so as to have a consumption of about 4½ cubic feet per hour and a flame with a green zone from 0.32 to 0.4 inch in height (meaning that the bunsen is drawing not more than 3 or 4 volumes of air) and *N* is gradually closed until T_2 stands at about 10° higher than T_1. This will take about a quarter of an hour. When the test is to be started, weigh the vessel which is to collect the water run through; note the temperatures of T_1 and T_2; have a rubber tube on *I* and promptly turn this into the water collecting vessel when the index of the experimental meter passes a zero point. Note the temperatures when the dial of the meter indicates consumption of 1 liter, 2, 3 and 4 liters. Now, suppose T_1 has stood all the time at 16° and the average of the 5 readings of T_2 was 27.8°; then the water has gained 11.8°. The gas used was 4 liters and the water collected in the collecting vessel was 1.705 kilograms. Then the gas burned (4 liters) has developed $1.705 \times 11.8 = 20.119$ kilogram calories, and a cubic meter of the gas would develop $20.119 \times 1{,}000/4 = 5{,}029$ calories. Reducing this to 0° and 760 millimeters barometric pressure, this would come to 5,320 calories per cubic meter. That is to say, that number of calories is liberated when the water is condensed; and that is the thing which it is useful to know, for under all circumstances of the best utilization of the heat by cooling of the products of combustion the steam is condensed out of these. In incandescent lighting very varying heating powers may bring out very similar temperatures, as Vivian Lewes and Sainte-Claire Deville have shown; and very much depends upon the specific gravity of the gas and the corresponding amount of drag it may have upon air in the Bunsen burner.

The errors of the apparatus described mostly arise from errors in reading the thermometers. With a difference of 10° between T_1 and T_2 an error of $\frac{1}{10}°$ in reading the thermometer means an error of 1 per cent. An error of one division on the dial of the meter in putting in or taking out the rubber tube which conveys the water into the water collecting vessel means an error of ½ per cent. There is an advantage in working with water initially very cold, and making the difference between T_1 and T_2 larger, say 20°. In practice the results never vary more than 3 per cent., and in steady testing not more than 1 per cent., while if tests be taken in groups of three, at 15-minute intervals, the average can be relied upon as exact.

Test of a Steam Turbine After Two Years' Service.

The following test is of interest, as there has been little information available concerning the deterioration of steam turbines and its effect on their performance. The tests were made by Profs. Edward F. Miller and R. R. Lawrence, of the Massachusetts Institute of Technology. The machine was a 150-horse power turbine made by the De Laval Steam Turbine Company, Trenton, N J., and had been in service continuously for the past two years at the New England Structural Company, East Everett, Mass., for furnishing power and light. Shortly before the test was made the turbine was taken apart and thoroughly examined. It was found that there was no appreciable wear on the pinion or buckets, and many of the latter still had part of the original scale formed when they were drop forged.

The machines were furnished under a guarantee not to consume over 18.7 pounds of steam per brake horse power per hour at full load, or 19.7 pounds at half load, when supplied with steam at 150 pounds pressure and exhausting into a vacuum of 26 inches. Comparing these figures with those obtained in the test it will be seen that the turbines are well within their original guarantees, indicating that the deterioration, if any, has apparently not affected the steam consumption. Following are items selected from the test:

Duration of test	.9 hours.
Steam pressure at turbine	145.9 pounds.
Number of nozzles in use	6
Quality of steam	98.95 per cent.
Barometer	29.90 inches.
Vacuum	25.47 inches.
Average total kilowatts	105.1
" " electrical horse power	142.2
" " brake horse power	160.4
" number of revolutions per minute	1,200
" steam per hour	2,826 00 pounds.
Steam per kilowatt hour	26.49 "
" " electrical horse power hours	20.05 "
" " brake horse power hour	17.62 "

From the account of the test submitted by the engineers it is evident that all proper precautions were taken, and the methods employed were consistent with the obtaining of accurate results.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

MR. HERMAN RUSSELL has resigned the position of Assistant Superintendent of the Cincinnati Gas and Electric Company.

MR. G. F. HARTMAN, who has had charge of the distribution division of the electric end of the properties of the Consolidated Gas and Electric Company, of Youngstown, O., has resigned.

THE contract for the construction of a 4-foot water gas set on the works of the Stroudsburg (Pa.) Company has been awarded to the Gas Machinery Company, of Cleveland, O.

THE gas business in Sunbury, Pa., is evidently in prosperous condition, if the extensive improvements now underway at that point may be considered a criterion. Superintendent Beck has just contracted for a 100,000-foot storage holder, is putting in additional exhauster and boiler capacity, and is enlarging and rearranging the plant at several other points. It is likely that new boxes will be added. In the town proper considerable extensions to the main system have been completed in time for the summer cooking season, and a special run of high pressure main has been laid direct to the works of the converting plant of the Susquehanna Silk Mills, with the proprietors of which the Company has a long term contract for the supply of a large quantity of gas. This gas to the silk mill is supplied by compressing pump and suitable tanks and regulating equipment direct, entirely independent from the town supply. Anyone remembering the conditions, of 169 consumers and a streak of rust, that Mr. Beck encountered in Sunbury 5 years ago on taking charge, can appreciate the transformation and the present volume of business that so steadily forges ahead, and which is a marked tribute to Mr. Beck's ability and good management.

L. F. CURTIN is informed that the Directors of the Kokomo (Ind.) Gas Company are Messrs. Knowlton L. Ames, Joseph C. Markley, R. C. Dawes, L. S. Owsley and B. S. Wallers.

THE new holder at the West Commercial street plant of the Portland (Me.) Gas Light Company is to be constructed by Messrs. R. D. Wood & Co., of Philadelphia.

THE Kansas Natural Gas Company has purchased the plant and franchises of the Ottawa Artificial Gas Company.

AT the annual meeting of the Kansas City, Missouri, Gas Company, the officers elected were: President, Hugh J. McGowan: First Vice-President, J. Crawford James; Second Vice-President, Randal Morgan; Secretary, R. McMillan; Treasurer, Lewis Lillie.

THE Suburban Gas Company, of Philadelphia, which has been renovating the building at 6th and Worth streets, is now ready to transact business in its new quarters. The building has been improved to the point of being thoroughly in keeping with the needs of such a growing corporation. A large clock has been placed outside on the 6th street wall for the use and instruction of the public, and it carries the significant sign, "Time to use gas!"

THE officers now in charge of the affairs of the Quincy (Ills.) Gas and Electric Company are: Directors, W. A. Vicy, J. H. Rice, J. T. Lynn, M. G. Borgmann and F. K. Pelton; President, J. T. Lynn; Treasurer, M. G. Borgman; Secretary, F. K. Pelton.

IT is understood that Mr. Louis McCarthy will succeed himself as city gas inspector for Detroit, Mich.

AT the annual meeting of the Bridgeport (Conn.) Gas Light Company, the officers elected were: Directors, Anthony N. Brady, A. B. Proal, C. F. Dieterich, A. E. Dieterich, John Sloane, I. de Ver Warner, de Ver H. Warner and Goodwin Stoddard; President, I. D. Ver Warner, Vice-President, de Ver H. Warner; Secretary, George H. Roberts; Superintendent, Chas. Gerdenier.

AT the organization meeting of the Commission, appointed to consider the working of the London sliding scale in respect to the Gas Companies of Massachusetts, which Commission was appointed under an act passed at the last session of the Massachusetts Legislature, Messrs. Barker, Cotter and Hall were appointed a Committee on Procedure. The Commission consists of Messrs. James E. Cotter, Charles P. Hall and the members of the State Board of Gas and Light Commisioners.

ADVICES by way of Columbus, O., dated June 28th are to the effect that the Crawford Gas and Electric Company, of Galion, O., is hereafter to be known as the Crawford County Gas and Electric Company, and that its capital stock has been increased to $200,000, of which $50,000 is preferred, bearing 6 per cent. interest. The officers of the concerns are: President, Selwyn N. Beakly; Secretary, R. O. Morgan.

UNLESS all signs fail Messrs. Pratt and Morton, of the Boone (Ia.) Company, will secure a franchise for the right to make and distribute gas in Ames, Ia. These gentlemen certainly know the gas business from first to last, and Ames could do no better than grant them "the right of way."

MR. JOHN C. KNIGHT will retire from the management of the Peoples Gas and Electric Light Company, of Oswego, N. Y., the 31st inst. His successor will be Mr. C. H. Dickerson, for some time in the service of Messrs. Street, Wykes & Co., who are the controllers of the Oswego properties.

ONE of the Committee of Arrangements of the Employees' Mutual Benefit Association, of the New York and Richmond Gas Company, of Staten Island, N. Y., writing under date of the 5th inst. says: "Our picnic held at Lazzari's Park, Rosebank, S. I., the evening, night and otherwise of the 3d inst, was a great success. Everything was harmonious and happy, and the big part of the credit for the affair should go to Mr. Charles J. Tracy."

IT is an open secret now that the selling rate at Newton and Watertown, Mass., will be put at $1.20 per 1,000 cubic feet, with a rebate of 20 cents on all bills settled on or before the 15th day after presentation. Good for Mr. Learned and his aides.

WE understand that Mayor Grainger is preparing an ordinance under which 6,000 shares of the stock owned by the city of Louisville in the Louisville Gas Company is to be disposed of at public auction. The proceeds of the sale are to go towards improving the city's sewerage system.

THE New Orleans (La.) Gas Light Company, through its Secretary Mr. Duncan Jones, has declared a dividend of 3 per cent., payable the 15th inst.

MR. M. E. MALONE, of the Denver (Col.) Gas and Electric Company, will have the supervisory directing of the new plant that is to be constructed at Grand Junction, Col. The local men most largely interested are Messrs. W. F. White and W. S. Wallace.

A CORRESPONDENT in Burlington, Ia., writes: "Some days ago the 50th anniversary of the Burlington Gas Light Company was celebrated by the shareholders, at which meeting it was resolved to renew the corporate existence of the Company for a period of 20 years. Articles of incorporation for the renewal of the corporation were ordered filed with County Clerk Sandquist. The total number of shares outstanding is 6,500, of which 5,841 were represented at the meeting. The original Burlington Gas Light Company was incorporated, June 18, 1855, with a capital stock of $65,000. The incorporators were Messrs Henry W. Starr, Fitz Henry Warren, J. F. Tallant, A. W. Carpenter, W. H. Postlewaite, W. Thompson, I. P. Sunderland, S. G. Lawmann, J. C. Hall and H. B. Spellman, all of whom have passed away."

"A. M. S.," writing to the JOURNAL under date of June 28th, says: Dear JOURNAL: Your item in the issue dated June 12th, mentioning a line of thought respecting the availability of cocoanut oil from the Philippines as a cheap source of gas making, particularly on the Pacific Coast, is fit to give a poor gas man, situated as I am at a remote point from available sources of many useful things to the body, a hope for better things. Galileo the famous said the earth revolved around the sun and was incarcerated for heresy. A colored man in our own South some years ago declared, "De Sun do move," and remained outside of jail the rest of his life. This rather proves that we live in a different age to that which nurtured poor Galileo, and that we are at liberty to announce any truth that we discover in the domain of science without holding fear respecting the wrath of the authorities. Are we not safe, therefore, in inviting to our living places the sage who has discovered gas in cocoanut oil and in assuring him that even in New York he will not be landed in jail, even by the combined effort and ukase of Governor Higgins and Mayor McClellan? It being *safe*, therefore, on the sage's account, the writer will venture to give out some further facts that have been known to him, for some time, but which the world may not be ready to hear. List me! Hush, 'sh., 'sh. Fresh butter, will do the same thing, and one doesn't have to climb trees to get it. We have also had identical results from several other well-known (in that they are reasonably familiar) substances, all of which are equally as cheap as cocoanut oil for making gas. Here is a short list of them: Pork gravy, drippens, scrapple, tallow candles, doughnuts, walrus oil, unsalted olives, New Orleans molasses, goose grease, whale blubber, the fat of young elephants. There is one more substance which, so far as my investigations have proceeded, yields nearly as good results as any obtained from out of the above list. In fact, the burning requisite is to get it cheap enough. I refer to ambergis. This makes a very rich gas, but at present the price is about $15 per pound, and as it would take about 2 pounds of it to do a day's cooking for an ordinary family, I fear I cannot say it will shortly come into general use. By all means let the sage from the Philippines come and lend his aid to those appointed as a Commission to regulate the quality and price of gas that may be sold in the Empire State.

THE Scranton (Pa.) Gas and Water Company has purchased the rights and properties of the Consolidated Water Company of that district.

THE following comes to us by way of Cincinnati, O.: "Judge Miller recently heard elaborate arguments on the injunction against the Louisville Gas Company, prayed by George Boone, a minority stockholder, to restrain the Company from continuing its arrangements for running pipe into the Meade county natural gas field. The injunction is asked in an amended petition filed in the old litigation in that case and sets out a number of reasons why the restraining order asked should be granted. The plaintiff says that the pressure of the natural gas yield in Meade county is decreasing rapidly, and that if any increased demands are made upon it it will not last more than 6 or 7 years. He says that the project is really one of destruction, having as its object the crippling of the natural gas fields in that section, and that its only result will be losses of more than $13,000 a year to the Louisville Gas Company. It is also asserted, that the operations may involve the Company in contempt of court complications as violating orders of court secured against it in the fight with the Kentucky Heating Company. The Louisville Gas Company claims that Mr. Boone is in reality not a plaintiff, as a minority stockholder alone, but represents the competing Kentucky Heating Company. The lessening flow and danger of the field being exhausted are denied, and it is asserted that only profit can result to the defendant by the consummation of its plans."

The Market for Gas Securities.

That midsummer dullness reigns in Wall street no court crier need announce. The market for gas shares of the city sort is practically at a standstill, and in the absence of orders of any kind, whether for short or long account the sharp shooters are taking their scalping chances to win "a half," less commissions and the Higgins-Odell stamp method. There have been no particular "shifts" in the lighting commission status, although many State patriots have signified their willingness to serve, even to standing by the pressure regulation end of the instructions. Consolidated closed to-day (Friday) at 189½ to 191.

Brooklyn Union is quiescent at the figures of a week ago, but there is good probability that the shadows in it now being cast betoken a coming event. Peoples, of Chicago, is about as strong as anything in the gas share active list. And it might prove a good bit of business to keep an open eye on both sorts of Lacledes. Public Service Corporation (N. J.) securities of all denominations are fairly booming.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 Wall Street, New York City.

July 10.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	Capital.	Par.	Bid.	Asked.
Consolidated	$73,177,000	100	189½	191
Central Union, Bonds, 5's	3,000,000	1,000	108½	110
Equitable Bonds, 6's	1,000,000	1,000	..	109
" 1st Con. 5's	2,800,000	1,000	118	120
Mutual	3,500,000	100	300	320
Municipal Bonds	750,000	..	..	..
New Amsterdam Gas Co.— Bonds, 5's	11,000,000	1,000	111	113
New York & Richmond Gas Co. (Staten Island)	1,500,000	100	35	..
1st Mtg. Gold Bds. 5 p. ct.	1,000,000	..	..	..
Northern Union, Bonds, 5's	1,250,000	1,000	104	106
New York and East River— Bonds 1st 5's	3,500,000	1,000	112	114
" 1st Con. 5's	1,500,000	..	106½	108½
Standard	5,000,000	100	125	130
Preferred	5,000,000	100	145	155
Bonds, 1st Mortgage, 5's	1,500,000	1,000	116	117
Yonkers	999,650	500	130	..
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	188	194
" " Bonds (5's)	15 000,000	1,000	113	115
Bay State	50,000,000	50	¼	⅝
" ncome Bonds	2,000,000	1,000	..	75
Binghamton Gas Works	450,000	100	..	65
" 1st Mtg. 5's	500,000	1,000	93	96
Boston United Gas Co.— 1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	6	7
" " Bonds, 5's	5,250,000	1,000	96	98½
Capital, Sacramento	500,000	50	..	45
Bonds (6's)	150,000	1,000	..	..
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Cincinnati Gas and Electric Co	29,500,000	100	107	107¼
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	97½	99
Columbus (O.) Gas Lt. & Heating Co	1,625,750	100	..	95
Preferred	2,026,500	100	107½	108
Consumers, Toronto	,000,000	50	200	204
Consolidated, Baltimore	11,000,000	100	88	..
Mortgage, 6's	2,600,000	..	..	118
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N. J.	1,000,000	100	15	17
" Con. Mtg. 5's	880,000	1,000	89½	92
Bonds	75,000	..	..	100
Detroit City Gas Co	4,925,500	50	..	50
" Prior Lien 5's	5,803,000	1,000	..	98
Detroit Gas Co., 5's	361,000	1,000	75	80
" Inc. 5's	16,000	100	98½	100
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	39	40
For Wayne	2,000,000	..	..	..
" Bonds	2,000,000	..	55	..
Grand Rapids Gas Lt. Co. 1st Mtg. 5's	1,225,000	1,000	104½	105
Hartford	750,000	25	190	200
Hudson County Gas Co., of New Jersey	10,500,000	..	104½	105½
" Bonds, 5's	10,500,000	..	107	108
Indianapolis	2,000,000	..	70	75
" Bonds, 5's	2,650,000	..	104½	105
Jackson Gas Co	250,000	50	82	..
" 1st Mtg. 5's	200,000	1,000	101	103½
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	36
Bonds, 1st 5's	3,333,000	1,000	102	104
Laclede, St. Louis	10,000,000	100	..	..
Preferred	2,500,000	100	97½	110
Bonds	10,000,000	1,000	108½	109
Lafayette Gas Co., Ind.	1,000,000	100	..	60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	143	145
Madison Gas & Elec. Co. " 1st Mtg. 5's	350,000	1,000	107½	108½
" 6 per cent. scrip, due 1910	100,000	25	85	87
Montreal, Canada	2,000,000	100	218	218½

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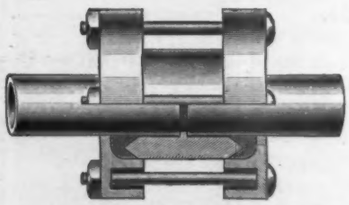
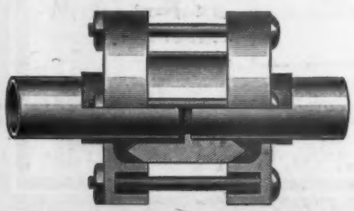


Regular Coupling, Style 1, for Plain End Wrought Iron Pipe.



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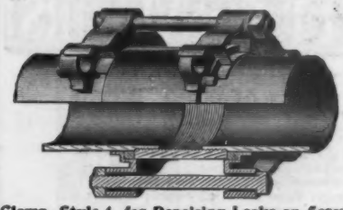
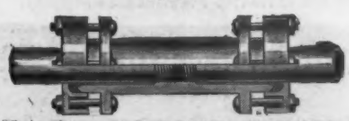


Clamp, Style 4, for Repairing Leaks on Screw Collar.



Long Sleeve, Style 2, for Mending Broken Lines.

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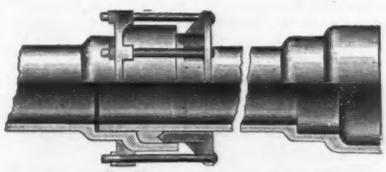
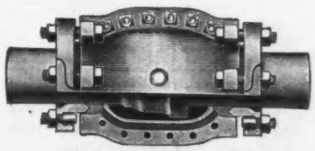
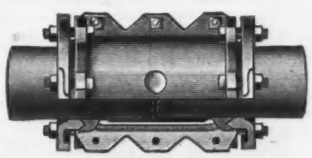


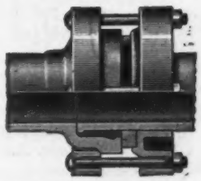
Coupling, Style 9, for Special Style Cast Iron Pipe.



Split Sleeve for Repairing Broken Bell on Cast Iron Pipe.



Split Sleeve for Repairing Broken or Cracked Cast Iron Pipe.



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DIVIDEND NOTICE.

OFFICE OF THE UNITED GAS IMPROVEMENT CO.,
N. W. CORNER BROAD AND ARCH STS.,
PHILADELPHIA, PA., June 14, 1905.

The Directors have this day declared a quarterly dividend of 2 per cent. (one dollar per share), payable July 15th, 1905, to stockholders of record at the close of business, June 30, 1905. Checks will be mailed.

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(Signed) HORACE McKAY,
Chairman Finance Committee.

Attest: BEMENT LYMAN,
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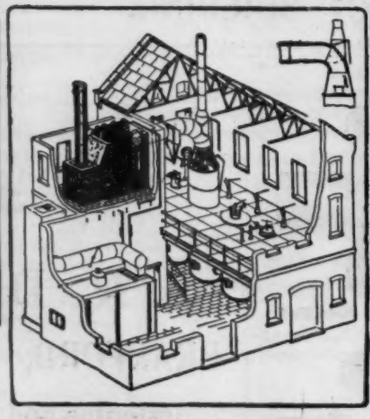

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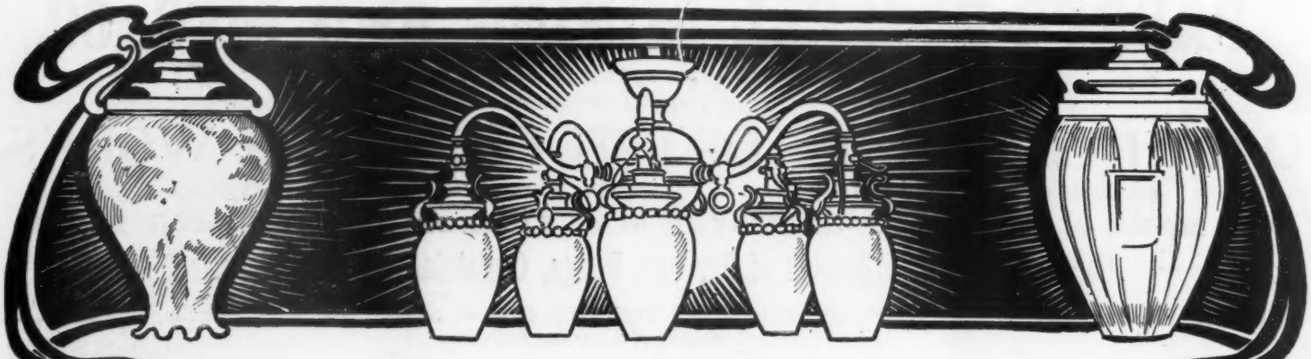

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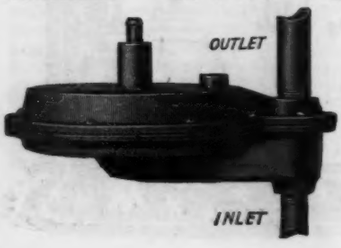

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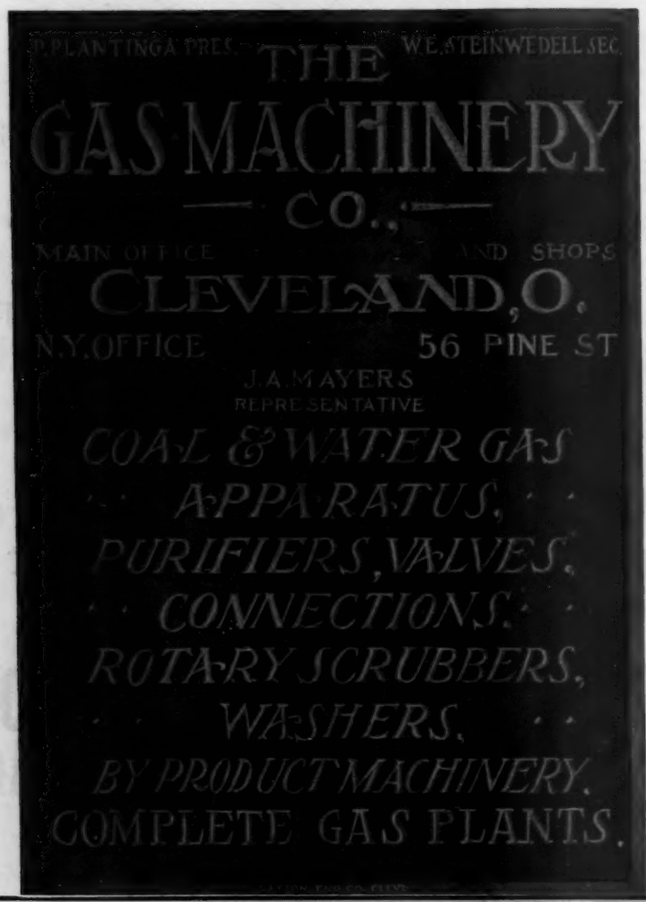

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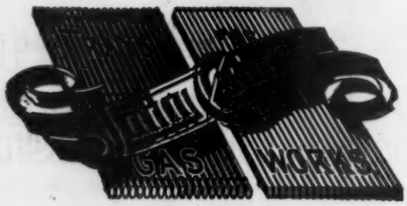

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Is the electrically operated, or trolley, system of transporting materials of whatever nature or size. Where no other method is possible, Telpherage overcomes the difficulty. It conveys over streets, driveways, railroad tracks, rivers, valleys, alongside precipitous cliffs or mountains, on straight lines or curves, or on any degree of incline. It brings into close communication the several departments of industrial establishments, and for relieving a freight-congested yard, depot, wharf or warehouse, is the best method in existence. We invite questions.

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PRESSURE GAUGE.

For continuous records of **Street Gas Pressure.**

Simple in construction, accurate in operation and low in price.

Fully Guaranteed. Send for Circulars.

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Gold Medal, St. Louis Exposition.

THE BEST are THE CHEAPEST.

HOMOGENEOUS CONSTRUCTION ~ PERFECT FINISH ~ LONGEST CONTINUOUS LIFE.

WE HAVE RETORTS MAKING GAS TO-DAY THAT HAVE BEEN IN CONSTANT USE FOR 52 MONTHS.

Awarded the Only **GRAND PRIZES** At St. Louis Exposition

BY A JURY COMPOSED OF THE MOST COMPETENT ENGINEERS OF FOUR CONTINENTS, FOR SUPERIOR

RETORTS * GAS BENCHES * FIREBRICK.

Designs and Estimates Cheerfully Furnished.

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You can buy burners that cost less than

BRAY BURNERS,

But all you save on the first cost will be lost a hundred times over in the increased number of complaints and dissatisfied consumers.

DON'T PUT GOOD GAS IN THE HOLDER AND SPOIL IT AT THE BURNER.

BRAY BURNERS

Have been used by the largest Gas Companies for over forty years, because

THE PROGRESSIVE GAS MAN ONLY WANTS THE BEST.

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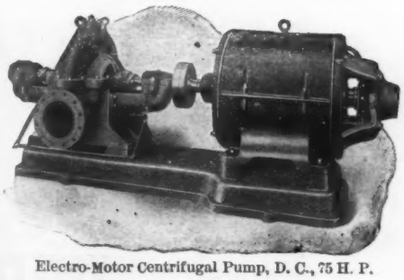
Have you a Bray Blue Book? SOLE AGENTS FOR THE UNITED STATES.



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Steam Turbine Motors
Steam Turbine Dynamos
Steam Turbine Blowers
Steam Turbine Centrifugal Pumps
Electro-Motor Centrifugal Pumps

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The Turbine Engineering Co.,	New York City, Chicago, Ill.
Denver Engineering Works Co.,	Denver, Col.
Florida Electric Co.,	Jacksonville, Florida.
Dravo, Doyle & Co.,	Pittsburg, Pa.
Geo. P. Dravo,	Milwaukee, Wis.
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Joshua Hendy Machine Works,	San Francisco, Cal.
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DE LAVAL STEAM TURBINE COMPANY
Works and Sales Offices, TRENTON, N. J.

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Ludlow Valve Mfg. Co.,

TROY, N. Y., U. S. A.

Double and Single Gate Valves, ¼" to 72",

—FOR—

Gas, Water, Steam, Oil, Ammonia, Etc.

HOT GAS VALVES A SPECIALTY.

Send for Catalogue.

"STEVEDORE." Plumbago Laid Manila Rope for hoisting purposes, is the **only rope that is not affected by exposure to the weather.** Eight sizes kept in stock for immediate shipment. Sold only by

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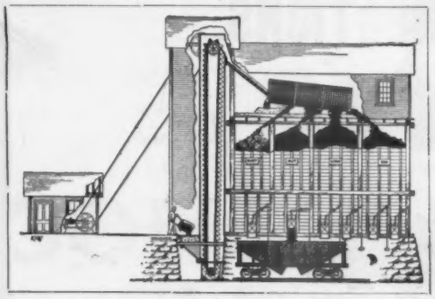
BODINE STREET, WEST NEW BRIGHTON, N. Y.
Samples and Prices on Application.



Coke-Crushing and Screening Plant,

Erected in 1903 for Keystone Coal and Coke Co., Greensburg, Pa.

The machinery consists of 2-roll Crusher, 46'6" centers Continuous Bucket Conveyor, and 4'6" dia. × 18' long Revolving Screen. The coke pocket is 38' × 21' × 21' high, and is equipped with gates and chutes for chuting coke to cars.

Write for Link-Belt Coal-Handling literature.

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The Gas Engineer's Pocket-Book,

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Comprising Tables, Notes and Memoranda relating to the Manufacture, Distribution and Use of Coal Gas, and the Construction of Gas Works.

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EMPIRE GAS IMPROVEMENT AND CONSTRUCTION CO.

This Company has purchased the patents and goodwill in the business hitherto carried on and owned by *A. M. Sutherland.* It is now ready to contract for the erection and installation of

ENTIRE GAS WORKS,

or any separate portion of the same, such as **Gasholders, Coal Gas Benches, Lowe-Sutherland** double-superheater **Water Gas Sets,** Scrubbers, Condensers, Exhausters, Purifying Boxes, Street Governors, Street Mains and Main Laying.

The high character of the work done by A. M. Sutherland during the past 15 years will be strictly adhered to and all work is warranted.

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IMMERSION WASHERS.

A design embodying particularly desirable features.

LLOYD CONSTRUCTION COMPANY,

Western Sales Agents for
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DETROIT, MICH.

MUELLER GAS METER CONNECTIONS.

CUP JOINT CONNECTION.

C—1039.

In making cup joints, if half the length of the fitting within the pipe should fit tight there will not be room left for enough solder to make a strong joint.

In making Mueller Cup Joint Meter Connections the pipe is swedged deep enough for the fitting to be clear of the pipe except at the end, so that solder can reach to the full depth of the insertion. They have plenty of solder to make them strong.

Mueller Cup Joint Meter Connections are made with regular pattern fittings, and the pipe is cup swedged. They are made in 270 sizes and specifications. The connections illustrated have male soldering nipples on one end and bent meter couplings on the other.

Each set of connections is carefully inspected and assembled, is given a 75-pound hydraulic pressure test, bears the Mueller trade mark, and is *unconditionally guaranteed.*

We also make tapping machines and ground key cocks for gas works' use. Catalogues upon application.

EASTERN DIVISION—Located at 254-258 Canal Street (cor. Elm), New York City, carries a full stock of Mueller goods.

THREE GRAND PRIZES were awarded Mueller Water, Gas and Plumbing goods, respectively, at St. Louis.

H. MUELLER MFG. CO.,

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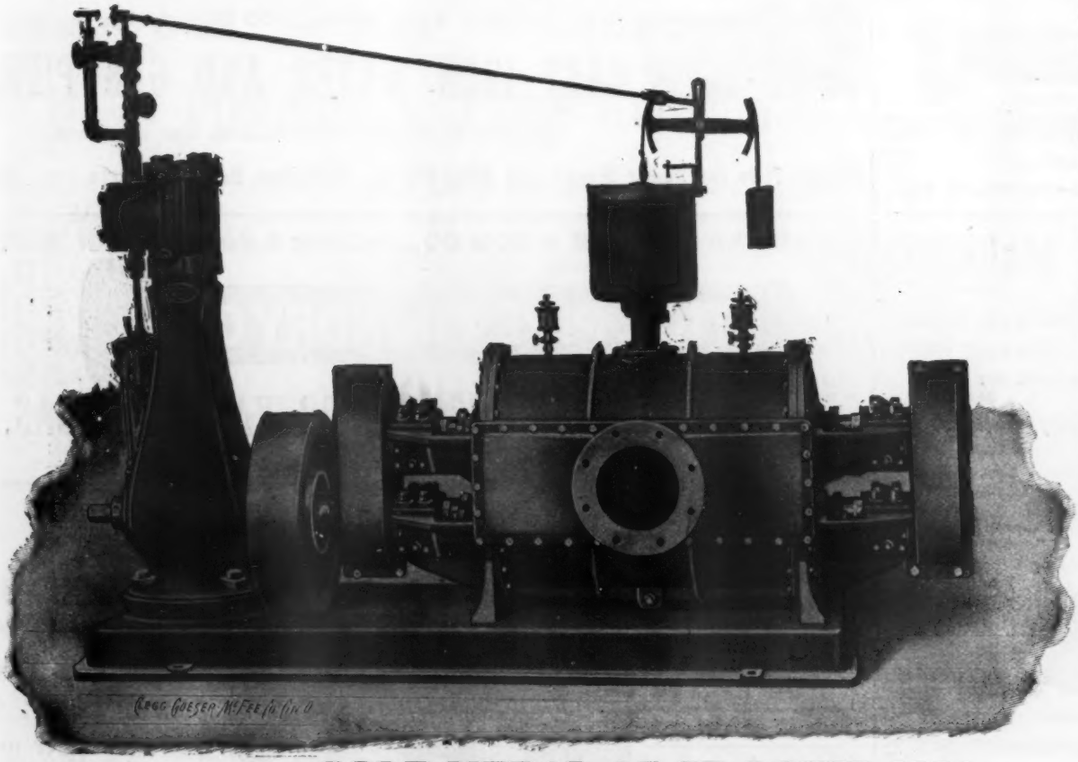
ROOTS' GAS EXHAUSTERS.



Sizes for any required capacity.

Self-oiling, adjustable bronze bearings.

Most perfect and sensitive Governor.

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WILL CONTINUE THE BUSINESS OF

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For Gas, Water and Electric Light Companies, at

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DONALDSON IRON COMPANY. EMAUS, PA.

MANUFACTURERS OF

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FOR WATER AND GAS.

Also, FLANGE PIPE, LAMP POSTS, Etc.

GAS TAPPING MACHINES

—FOR—

Drilling and Tapping Pipe under Pressure

WITHOUT ANY ESCAPE OF GAS.

They are Strong and Compact.

Size of Combination Drills and Taps ¾ to 4-inch.

Machines Sent to any Gas Company for Thirty Days' Trial.

Send for Circulars.

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DAYTON, O.

MUELLER COMBINATION TAPPING MACHINE.

The Mueller "Combination" Tapping Machine can be used with the gas cylinder for tapping under pressure, or without it for dry pipe tapping. This interchangeable feature makes it a very valuable tool for plants having both kinds of work to do with a small allowance for tools. Makes dry taps up to 3-inch and pressure taps up to 2-inch. Unconditionally guaranteed. Catalogues upon application.

C—1102.

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Globe Street and Boulevard Lamps.

Cheapest and Best
THOUSANDS IN USE WITH INCANDESCENT BURNERS.

Send for Catalogues.

THOMAS T. W. MINER,
821-823 Eagle Av., N. Y.

GASHOLDER TANKS AND GAS WORKS MASONRY COMPLETE.

Plans prepared and Estimates furnished at short notice.

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CAST IRON WATER AND GAS PIPE,

FROM THREE TO FORTY-EIGHT INCHES DIAMETER. ALSO, ALL SIZES OF

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Flanged Pipe and Fittings, Hydrants, Gates, Pig Lead, etc. etc.

UTICA PIPE FOUNDRY CO.

Manufacturers of Lead Pipe, Solder, etc., and Jobbers of Plumbers' and Tinners' Goods.

CAST IRON PIPE and SPECIALS FOR WATER AND GAS.

Wholesale Eastern Agents AKRON VITRIFIED SEWER PIPE.

SAFETY GAS MAIN STOPPER COMPANY,

For Shutting Off Gas in Mains

Any size gas main can be shut off in 30 seconds. : : :

Temporarily during alterations and repairs. : : : :

STOPPERS SENT ON TRIAL.

Address: SAFETY GAS MAIN STOPPER CO., 1668 Park Ave., New York City.

This is No. 2.

Height, 36 inches.
Diameter, 12 "
Shipping weight, 80 lbs.
Net weight, 50 lbs.
The products of combustion are entirely separate from the water. Entire water surfaces are tinned.

Price, $35.00.

HOT WATER

FOR BATHROOM AND KITCHEN

is most easily, quickly and economically supplied by a

Humphrey Crescent Instantaneous Water Heater.

Prices range from $20 to $45.
Every Heater GUARANTEED.

Set a heater for every gas consumer. You will please them and increase sale of gas at the same time.

Send to-day for catalogue and discounts to

HUMPHREY CO.,
Kalamazoo, Mich.,

The only manufacturers in the World of a COMPLETE LINE OF INSTANTANEOUS WATER HEATERS.

GEORGE R. ROWLAND,
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Drawings, Specifications and Estimates furnished for the construction of new works or alteration of old works. Special attention given to Patent Office drawings.

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P. O. BOX 2043, PHILADELPHIA, PA.

AMERICAN METER CO.,

NEW YORK, ST. LOUIS, PHILADELPHIA, SAN FRANCISCO, CHICAGO,

Photometrical and Experimental Apparatus.

PUBLIC LIGHTING TABLE.

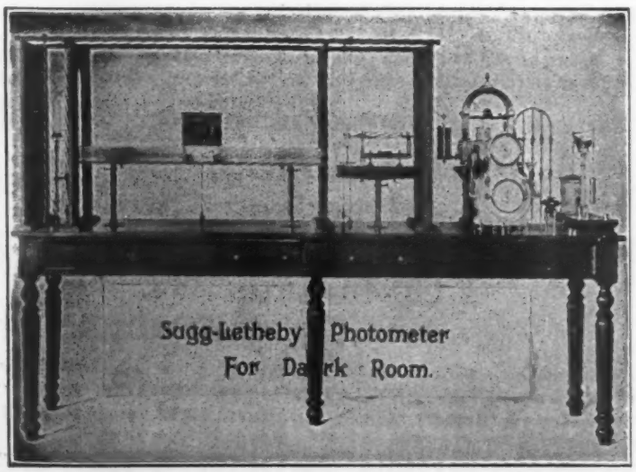
JULY, 1905.

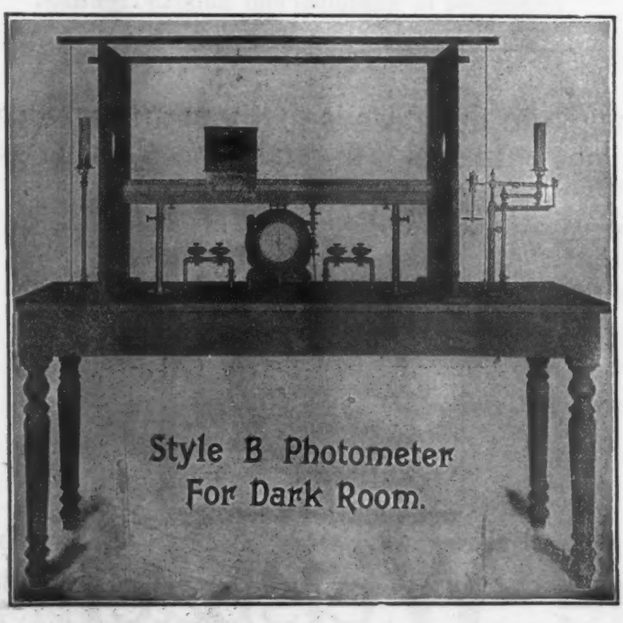
Day of Week.	Table No. 1. FOLLOWING THE MOON. Date.	Light.	Extinguish.
Sat.	1	8.00 PM	3.30 AM
Sun.	2	8.00 NM	3.40
Mon.	3	8.00	3.40
Tue.	4	8.00	3.40
Wed.	5	8.00	3.40
Thu.	6	8.00	3.40
Fri.	7	9.50	3.40
Sat.	8	10.30	3.40
Sun	9	11.00 FQ	3.40
Mon.	10	11.40	3.40
Tue.	11	12.20 AM	3.40
Wed.	12	1.00	3.40
Thu.	13	1.50	3.40
Fri.	14	2.50	3.40
Sat.	15	No L.	No L.
Sun.	16	No L. FM	No L.
Mon.	17	No L.	No L.
Tue.	18	8.00 PM	9.50 PM
Wed.	19	8.00	10.20
Thu.	20	8.00	10.50
Fri.	21	8.00	11.20
Sat.	22	8.00	11.50
Sun.	23	7.50	12.20 AM
Mon.	24	7.50 LQ	12.50
Tue.	25	7.50	1.20
Wed.	26	7.50	2.00
Thu.	27	7.50	2.40
Fri.	28	7.50	3.50
Sat.	29	7.50	3.50
Sun.	30	7.40	4.00
Mon.	31	7.40 NM	4.00

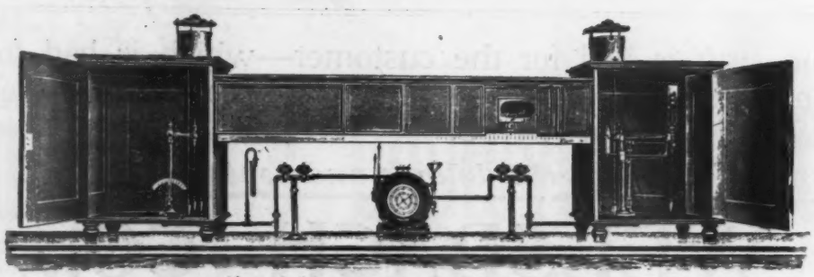
TOTAL HOURS DURING 1905.

By Table No. 1.

	Hrs.Min.
January	240.50
February	192.20
March	207.00
April	175.10
May	161.00
June	139.50
July	149.00
August	161.50
September	173.00
October	205.00
November	211.00
December	229.00
Total, yr.	2245.00







Closed Photometer For Light Room.

CIRCULARS SENT ON REQUEST.

PUBLIC LIGHTING TABLE.

JULY, 1905.

Day of Week.	Table No. 2. NEW YORK CITY. All Night Lighting. Date.	Light.	Extinguish.
		P.M.	A.M.
Sat.	1	7.30	3.15
Sun.	2	7.30	3.15
Mon.	3	7.30	3.15
Tue.	4	7.30	3.15
Wed.	5	7.30	3.15
Thu.	6	7.30	3.15
Fri.	7	7.30	3.15
Sat.	8	7.30	3.15
Sun.	9	7.30	3.15
Mon.	10	7.30	3.15
Tue.	11	7.30	3.15
Wed.	12	7.30	3.15
Thu.	13	7.30	3.15
Fri.	14	7.30	3.15
Sat.	15	7.30	3.15
Sun.	16	7.20	3.15
Mon.	17	7.20	3.15
Tue.	18	7.20	3.15
Wed.	19	7.20	3.15
Thu.	20	7.20	3.15
Fri.	21	7.20	3.15
Sat.	22	7.20	3.15
Sun.	23	7.20	3.15
Mon.	24	7.20	3.15
Tue.	25	7.20	3.15
Wed.	26	7.20	3.15
Thu.	27	7.20	3.15
Fri.	28	7.20	3.15
Sat.	29	7.20	3.15
Sun.	30	7.10	3.30
Mon.	31	7.10	3.30

TOTAL HOURS DURING 1905.

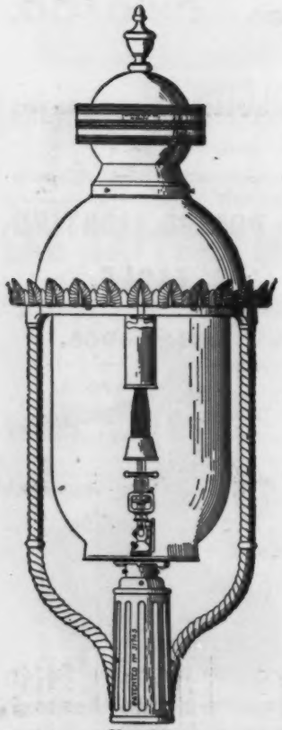
By Table No. 2.

	Hrs.Min.
January	423.20
February	355.25
March	355.35
April	298.50
May	264.50
June	234.25
July	243.45
August	280.25
September	321.15
October	374.30
November	401.40
December	433.45
Total, yr.	3987.45

NEW YORK, 97 Liberty Street. BOSTON, 814 Beacon Building. PHILADELPHIA, Broad and Arch Streets. ST. LOUIS, 712 Roe Building. CHICAGO, Foot of Orleans Street. SAN FRANCISCO, 712 Polk Street.

WELSBACH STREET LIGHTING COMPANY

.... OF AMERICA ....



No. 36.

Controls and Operates the

Welsbach System of Street Lighting,

Which includes its specially DESIGNED AND PATENTED BURNER for STREET and PARK LIGHTING exclusively.

Uniformly SUCCESSFUL in 150 Cities and Towns.

By means of the Welsbach System of street lighting the superiority of GAS over electricity for street lighting has been fully demonstrated.

POINTS OF MERIT:

It is { Economical, Attractive, Successful, Up-to-date.

IT LIGHTS THE STREET.

Where there are no gas mains we can furnish an equally good light by our SELF-GENERATING NAPHTHA WELSBACH BURNER, and thereby supply a uniform light in all localities.

Correspondence Solicited from Gas Companies and Others interested in Municipal and Outside Lighting.

No. 38.

AN underlying principle in business is to show an increase each year---to grow. The astute dealer not only seeks to retain this year's customers, but to attract new trade next year.

The formula is simple---

THIS SHIELD IS THE WELSBACH TRADE MARK.

IT IS A GUARANTEE AND A PROTECTION.

Sell The Welsbach Brands.

The imitation stuff is bad for the customer---which is bad for you.

The genuine Welsbachs---Burners or Mantles---make satisfied customers---keep customers---MAKE NEW ONES.

And your profit isn't merely dollars and cents.

WELSBACH CO.,

Broad and Arch Sts., PHILADELPHIA.

THE UNITED GAS IMPROVEMENT COMPANY

For the Year Ending December 31st, 1904, has been Awarded Contracts for 45 Sets of

Standard Double-Superheater Lowe Water Gas Apparatus.

PARTIAL LIST OF PLACES:

Harrisburg, Pa.
Pelham, N. Y.
Reading, Pa.
Augusta, Me.
Bangor, Pa.
Woonsocket, R. I. (2d contract).
Brooklyn, N. Y. (4th contract).
Cincinnati, O. (2d contract).
Scranton, Pa. (3d contract).
New York City (14th contract).
New Haven, Conn. (2d contract).
Watertown, N. Y.
Tampa, Fla. (3d contract).
Westchester, N. Y. (3d contract).
Bridgeport, Conn. (2d contract.)
St. Paul, Minn. (2d contract).
Springfield, Mass. (2d contract).
Lynn, Mass. (5th contract).
Rochester, N. Y.
Battle Creek, Mich.
Mechanicsburg, Pa.
Excelsior Springs, Mo.
Bristol, Conn.
Jersey Shore, Pa.
Vicksburg, Miss.

TOTAL SETS, 1904, ... 45
TOTAL DAILY CAPACITY, 1904, ... 56,325,000 cubic feet.
TOTAL SETS TO DATE, ... 553
TOTAL DAILY CAPACITY, ... 419,180,000 cubic feet.

The United Gas Improvement Company,

Broad and Arch Streets, Philadelphia.

Established 1858. Incorporated 1890.
CHAS. E. GREGORY, Prest. DAVID R. DALY, V.-Prest. & Treas.
H. D. ABERNETHY, Sec.

J. H. Gautier & Co.

Greene & Essex Streets,
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CLAY GAS RETORTS, FIRE CLAY TILES, FIRE BRICK and FIRE CLAY SPECIALTIES.

Ground Fire Clay, Fire Sand and Ground Fire Brick in Barrels and Bulk.

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FLEMMING GENERATOR GAS FURNACE

Brooklyn Fire Brick Works,

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NATIONAL PYROGRANIT COMPANY,

MANUFACTURERS OF

Fire Brick, Tiles, Special Shapes, etc.

NEW YORK OFFICE:
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WORKS:
South River, N. J.

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Consulting Engineer

AND

CONTRACTOR,

PARK ROW BUILDING, N. Y.

Established 1846.

Adam Weber Sons.

Manhattan Fire Brick and Enameled Clay Retort Works.

Works at Weber, on the Raritan River, Middlesex County, N. J.

GENERAL OFFICES: Park Row Bldg., N. Y. City.

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Modern Coal Gas Plants,

With either Horizontal or Inclined Retorts, Half-Depth and Full-Depth Recuperative Furnaces, Adam Weber Patents.

MODERN BENCH IRONWORK.

Linings for Water Gas Apparatus, High Grade Fire Brick of All Descriptions, Ground Fire Clay, Ground Fire Brick in Bulk or Barrels.

ISAAC C. BAXTER, President.
Works.
LOCKPORT STATION, PA.

ESTABLISHED 1864.

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PETER YOUNG, Secretary and Treas.
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Fire Clay Goods for Gas Works.

HENRY MAURER & SON,

(ESTABLISHED 1856.)

EXCELSIOR FIRE BRICK & CLAY

RETORT WORKS

WORKS, Perth Amboy, N. J.
OFFICE, 418 to 422 East 23d St., N. Y.

Clay Gas Retorts,

BENCH SETTINGS,

Fire Brick, Tiles, Etc.

GEROULD'S IMPROVED RETORT CEMENT

A Cement of great value for patching retorts, putting on mouthpieces, making up all bench-work joints, lining blast furnaces and cupolas. This cement is mixed ready for use. Economic and thorough in its work. Fully warranted to stick.

Price List, f.o.b. BLOOMINGTON, INDIANA.
In Casks, 400 to 800 pounds, at 5 cents per pound.
In Kegs, 100 to 200 " " 6 " "
In Kegs less than 100 " " 7 " "

C. L. GEROULD, BLOOMINGTON, IND.

For orders East of Buffalo, N. Y., or Pittsburg, Pa., freight will be paid to these points.

THE ECONOMICAL GAS APPARATUS CONSTRUCTION COMPANY, LIMITED,

Consulting Engineers.

Builders of UP-TO-DATE Machinery and Appliances for Coal and Water Gas Plants. :: :: :: :: ::

PLANS,
SPECIFICATIONS
AND ESTIMATES
PREPARED.

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THEO. J. SMITH, Prest. J. A. TAYLOR, Sec
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BALTIMORE RETORT & FIRE BRICK CO.

MANUFACTORY AT

LOCUST POINT, BALTIMORE, MD.

Clay Retorts, Blocks & Tiles

FIRE BRICK, FIRE CLAY, AND FIRE CEMENT.

Our Improved Half and Full Depth Benches have been Adopted by Many Gas Companies.

WALDO BROS., 102 MILK ST., BOSTON, MASS.

Sole Agents for New England States.

JOHN DELL,
President and General Manager.

MISSOURI FIRE BRICK CO.,

ESTABLISHED 1882.

MANUFACTURERS OF

Gas Retorts, Bench Settings, Fire Brick, Cupola Linings, Etc.

We are the **Exclusive Agents** *for the* **Mitchell Patent Benches,** *Constructed with Half or Full Depth Furnaces, to Burn either Coal or Coke, and Arranged for Front or* **Rear Clinkering.** **The Mitchell** *is the* **Original Coal Firing Bench.** *We also Erect Plain Benches with* **One to Six Retorts.**

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Bronder Patent Stoking Machinery.

Three-Scoop and Three-Rake Charging and Discharging Machines are operating in New York, Newark, N. J., Philadelphia, Worcester, Mass., Mt. Vernon, N. Y., Toronto and Montreal, Canada.

Four-Scoop and Four-Rake Charging and Discharging Machines are operating in Detroit, Mich.

These are the only machines that will draw or charge simultaneously 3 or 4 retorts (vertically) and handle from 42 to 60 retorts in from 25 to 30 minutes, lid opening and closing and filling of furnaces included.

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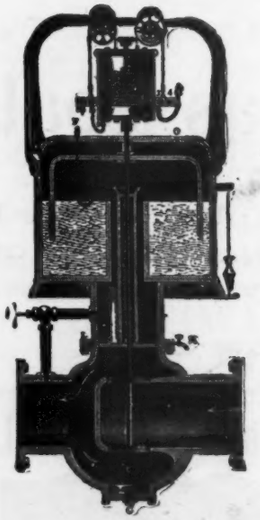

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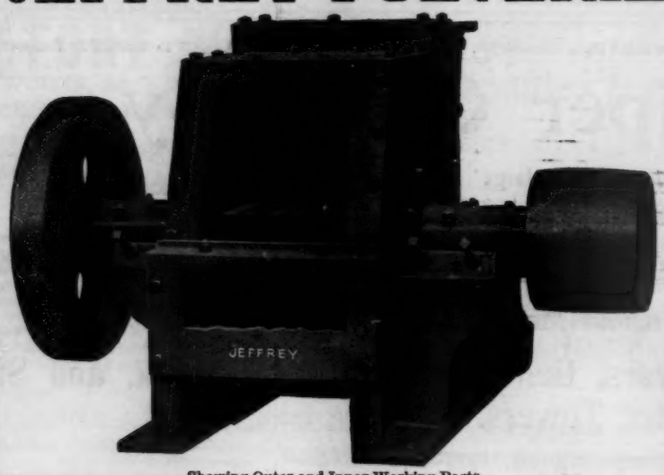

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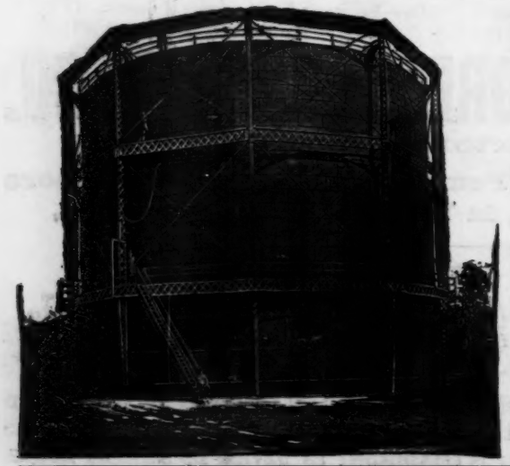

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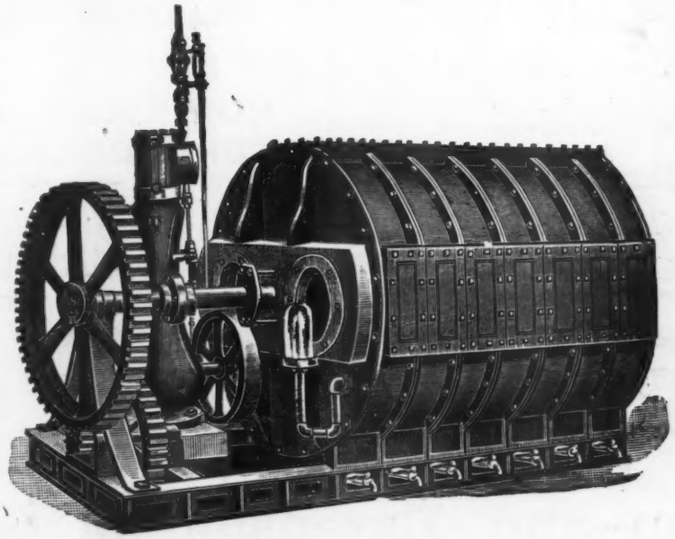

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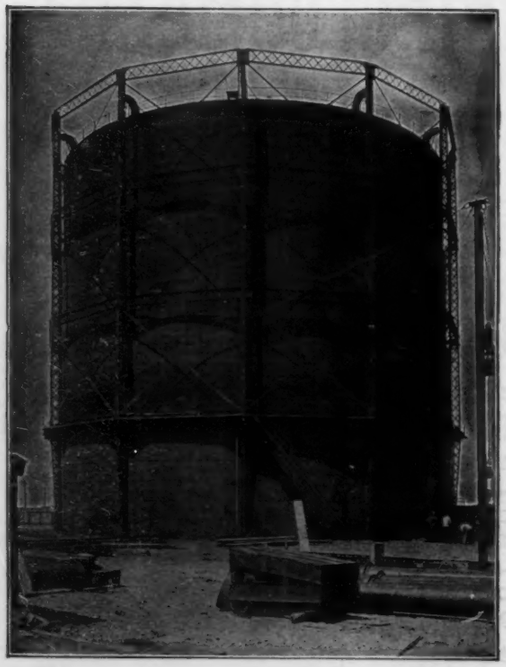

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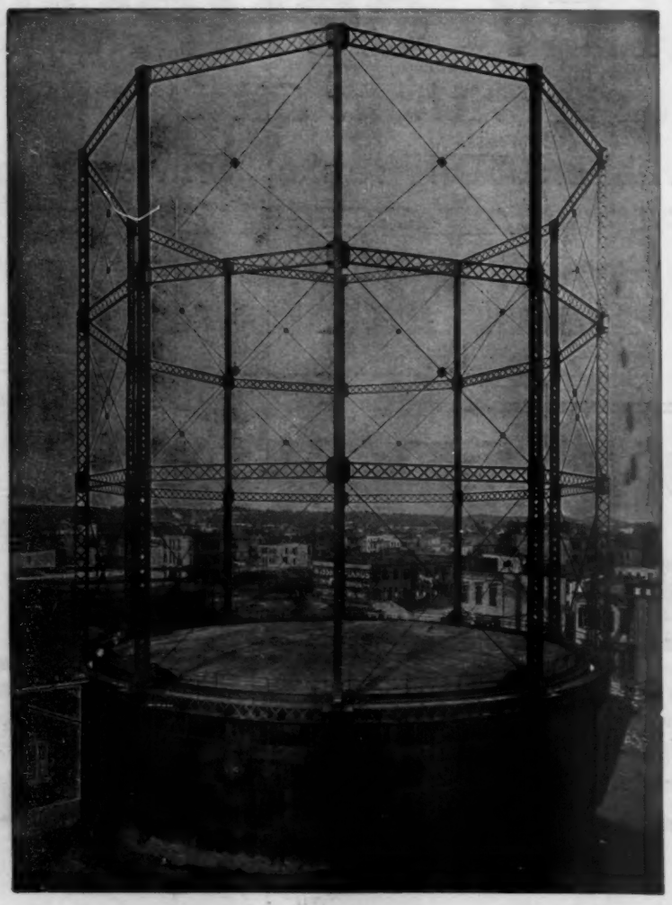

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